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with the Author's Compl.ts

ON THE

MUSCULAR ARRANGEMENTS

OF THE

BLADDER AND PROSTATE

AND THE MANNER IN WHICH THE URETERS AND URETHRA ARE CLOSED.

BY

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XX. *On the Muscular Arrangements of the Bladder and Prostate, and the manner in which the Ureters and Urethra are closed.* *By* James Bell Pettigrew, *M.D. Edin., First Assistant in the Museum of the Royal College of Surgeons of England. Communicated by* Dr. Sharpey, *Sec. R.S.*

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The arrangement of the muscular fibres of the bladder is exceedingly intricate, and notwithstanding the large share of attention devoted to it, remains to a considerable extent unexplained. A cursory examination of the literature of the subject will serve to show that many of the statements advanced in elucidation of this difficult point of minute anatomy are more or less conflicting. Lieutaud* and Sabatier† described the fibres as pursuing no definite course, but as crossing in all directions to form a complete network of unequal meshes; while Galen‡ enumerated three distinct orders of fibres, viz. a longitudinal, an oblique, and a circular, "Vesicarum tunicæ rectos rotundos et obliquos habent villos."

Duverney§, Lauth ||, Huschke¶, and Cruveilhier** were of opinion that the fibres of the bladder might be separated into an external layer consisting of straight or longitudinal fibres, "musculor detrusor urinæ" (Lauth), and an internal layer composed of oblique circular fibres, the oblique fibres, according to them, being developed most fully towards the cervix, where they form the "sphincter vesicæ."

Guthrie†† gives a very similar account. He recognizes an external longitudinal layer and an internal one, the fibres of which run in a spiral, oval, and transverse direction.

Barkow‡‡ and Ellis §§ indicate three layers, an external longitudinal, a middle circular, and an internal reticular or submucous.

Winslow ||| carried the separation further, and maintained that the fleshy fibres of

* Hist. de l'Acad. des Sciences, 1753, p. 99.

† Traité Compl. d'Anat. Paris, 1777.

‡ De usu partium, lib. v. cap. xi.

§ Œuvres Anat. 1761.

|| Nouveau Manuel de l'Anatomiste. Paris, 1835.

¶ Encyclop. Anat. trad. Jourdan. Paris, 1845.

** Anat. Descript. 3e édit. 1852.

†† On the Anatomy and Diseases of the Urinary Organs and Sexual Organs. By G. J. Guthrie, F.R.S. Lond. 1843.

‡‡ Anatomy of the Muscular Fibres of the Human Bladder. Breslau, 1858.

§§ "An Account of the Urinary and certain of the Generative Organs of the Human Body. By George Viner Ellis, Prof. Anat. Univ. Coll. Lond.," Med. Chir. Trans. vol. xxxix.

||| The Anatomy of the Human Body. Lond. 1766, sect. viii. § 452.

the bladder may be divided into several layers, the fibres of the first or most external layer having a longitudinal direction, those which come next being inclined on either side of the longitudinal one, the succeeding or deepest fibres, which are the most oblique, gradually becoming transverse. This author pointed out the important fact that the fibres mutually cross each other.

A. Sabatier* in a recent memoir divides the fibres into a superficial layer of longitudinal fibres—a deeper layer of oval fibres, a still deeper one of circular or elliptical fibres, and a layer of internal or deep longitudinal fibres. The external longitudinal fibres, in his opinion, surround the summit of the bladder, and form with those of the opposite side a sort of cravat (*cravate*) behind the base of the urachus, other and similar fibres passing beneath the neck of the bladder to form an inferior cravat. The superficial fibres, as will be observed from this description, are continuous towards the apex and base. The oval fibres, he remarks, form loops (*anses*), which, being transverse on the anterior surface and oblique on the sides, converge and diverge posteriorly to form the italic letter *x*. The circular or elliptical fibres, according to Sabatier, extend from the summit of the bladder to the cervix vesicæ and form complete circles; the deep longitudinal or internal ones, which he regards as the internal prolongations of the urachus, intersecting the circular fibres at right angles, and being continued into the prostatic portion of the urethra.

Other authors might be cited, as Douglas, Rutty, Pearson, Thompson, Sappey, Mercier, &c., but the opinions already quoted embrace, as far as I am aware, everything at present known of the general arrangement. The sphincter, trigone, and muscles of Bell have been described separately and variously. Guthrie†, assisted by Messrs. Taylor, Bedford, and Hancock, altogether failed to detect a sphincter for the bladder, and came to the conclusion that no circular fibres surround the neck of the organ; whereas Rutty ‡, as early as 1750, speaks of a complete sphincter in the shape of a small muscle of circular fibres which invests the neck of the bladder and prevents the involuntary emission of the urine. The sphincter vesicæ was regarded by Huschke † as being less regular and distinct than the internal sphincter of the anus, and Sir Charles Bell § describes it as consisting of a semicircular band of fibres about half an inch in breadth, and particularly strong on the under surface of the cervix; the fibres of the upper portion of the band, which are fewer in number and weaker, dispersing themselves in the substance of the bladder. Sabatier † and Bell † gave it as their belief that the trigone and luette are the most sensible parts of the bladder, and Mor-

* Recherches Anatomiques et Physiologiques sur les Appareils Musculaires Correspondants à la vessie et à la prostate dans les deux sexes. Paris, 1864.

† *Op. cit.*

‡ A Treatise on the Urinary Passages. By William Rutty, M.D. Lond. 1750.

§ A Treatise on the Diseases of the Urethra, Vesica Urinaria, Prostate, and Rectum. By Charles Bell. 3rd edit. With Notes by John Shaw. Lond. 1822.

GAGNI * and SANTORINI † state that at the points where the ureters terminate in the bladder there arises from each of them a thick, round, compact, fleshy body, which takes a downward direction, and having proceeded a little way, unites with its fellow and terminates in the caput gallinaceum. The bodies referred to were described by LIEUTAUD ‡ under the term "La trigone de la vessie," and Sir CHARLES BELL regarded them as distinct muscles. This anatomist believed that they terminated in the third lobe of the prostate, and not in the caput gallinaceum, as averred by MORGAGNI and SANTORINI. In this, however, as I shall have occasion to show, he was mistaken.

The accounts given of the distribution of the fibres in the prostate are few in number, from the fact that the authors who have turned their attention to the anatomy of the gland have for the most part described either its microscopical structure or pathological conditions. ELLIS ‡ regards the prostate as being essentially a muscular body, consisting of circular or orbicular involuntary fibres, which are directly continuous behind with the circular fibres of the bladder, and in front with the circular fibres of the membranous portion of the urethra. It is, in his estimation, "only a largely developed portion of the circular muscular layer that invests all the urethra behind the bulb, or the spongy portion." The few longitudinal fibres which, according to ELLIS, occur on the upper surface of the prostate, are, he says, derived from the external layer of the bladder, and can scarcely be said to form part of the gland. According to HODGSON §, the prostate is made up of two structures, a soft yellowish series of vesicles and their ducts, and a more or less firm tissue laid between the glandular matter and connecting it together. The firm tissue in some instances forms the greater part of the gland, and in his opinion proceeds from the internal aspect of the capsule. It consists of unstriped muscular fibres, with white fibrous and yellow elastic tissues intervening. This author agrees with ELLIS in believing that the circular muscular fibres of the prostatic portion of the urethra are not separable from the muscular structure of the prostate itself, the division being, as he states, the result of dissection and artificial. His description runs as follows:— "The muscular structure, from the mucous membrane of the urethra to the capsule of the prostate, may be considered as the general muscular coat of the urethra interspersed with glandular tissue, and somewhat altered in arrangement and form to adapt it to this condition." A. SABATIER ‡ thus tabulates the several layers of the urethra and prostate, as seen in section and enumerated from within. 1. Mucous membrane. 2. Longitudinal fibres. 3. Layer of deep circular fibres concentric with the canal of the urethra, and continuous with the circular layer of the bladder. 4. Longitudinal fibres placed outside that layer, and only existing behind the canal. The longitudinal fibres are the terminations of the oval fibres which enter the prostate directly. 5. A very thick layer of circular superficial fibres which compose almost the whole mass of the prostate.

* MORGAGNI, Adversaria, i. n. 9, Adversaria iii. Animadver. xlii.

† Observationes Anatomicæ, cap. x. sec. xxi. ‡ *Op cit.*

§ The Prostate Gland and its Enlargement in Old Age. By DECIMUS HODGSON, M.D. Edin., M.R.C.S. Eng. Lond. 1856.

These fibres are eccentric to the deep circular fibres surrounding the canal of the urethra, and contain the glandular substance in a kind of network. 6, and lastly. The capsule, composed of fibrous tissue, which serves at once for a covering for the gland and a tendon of insertion for some of the fibres of the bladder. The prostate, according to SABATIER, consists almost exclusively of circular fibres, but the gland, in his opinion, is not a continuation of the bladder, although some of the fibres of the bladder terminate in it. He differs from ELLIS and HODGSON in describing two sets of circular fibres; the one belonging to the urethra, the other to the prostate proper. In this he is followed by HENLE *, who figures the two sets of circular fibres referred to, and indicates (towards the apex of the gland) the presence of striated or voluntary muscular fibres.

LEUCKHART † describes a true rudimentary prostate in the female, which consists principally of mucous follicles, and is situated between the beginning of the urethra and the reflexion of the vagina ‡.

From what has been stated, it will be evident that the arrangement of the fibres in the prostate, and their precise relations to those of the urethra and bladder, is by no means well ascertained. It will further appear that those who have described the fibres of the bladder as running in all directions have not attempted to trace their courses or localize them; while those who have done the latter have given a very imperfect account of the direction of the fibres forming the layers they have enumerated. In conclusion, no attempt has been made to reconcile the statements of SABATIER and HENLE with those of ELLIS and HODGSON, or the descriptions of LIEUTAUD and SABATIER with those of DUVERNEY, LAUTH, HUSCHKE, and CRUVEILHIER—the former describing structures remarkable for their complexity, the latter for their extreme simplicity.

The difficulties experienced in unravelling and tracing the fibres of the bladder and prostate sufficiently account for the discrepancies. With a view to simplifying the arrangement, I have in the present instance distended the bladder and urethra with liquid plaster of Paris, this substance preserving the soft contour of the viscus, and, when set, enabling me to dissect even individual fibres with a surprising degree of precision §. In many instances I have hardened the bladders so prepared in alcohol, bisected them in various directions, and removed the plaster, so as to render them

* Handbuch der Systematischen Anatomie des Menschen, von Dr. J. HENLE, 1866.

† *Vide* article on WEBER's Organ, in Illustr. Med. Zeitung, 1, 2.

‡ "VIRCHOW also admits the existence of the rudimentary prostate in females, and says that he has often found at the neck of the bladder, especially in old women when the internal orifice is thickened, round greyish-yellow enlargements, in which there are gradually formed firm dark-coloured bodies lying imbedded in the mucous membrane. These bodies he considers identical with, or analogous to, the concretions found in the prostatic portion of the urethra" (VIRCHOW's Archives, vol. iii. 1853).

§ In order to obtain a dark background, against which to contrast the direction of the fibres, I added ultramarine blue to the plaster before mixing it with water. The deep colour shines through the semi-transparent walls, and causes the fibres to stand out in relief. The plaster sets in a very few minutes and keeps perfectly in spirit.

transparent. In this way I have obtained illustrative views of all parts of the parietes, and particularly of the apex and fundus. By rendering the bladder transparent, the various sets of fibres can be accurately traced, their direction contrasted, and their relative position in the vesical parietes determined both from without and from within. The varying degrees of thickness in the muscular wall can likewise readily be made out. The prostate has been examined by slicing it in all directions, and by macerating it and tracing out the fibres by the aid of needles. My dissections, some sixty in number, have in all instances supplied me with my description, and have for the most part been carefully photographed in illustration. They are preserved and catalogued in the Museum of the Royal College of Surgeons of England; and I take this opportunity of acknowledging my obligations to the Council of the College for the facilities afforded me in their preparation. By adopting the methods explained, I have obtained remarkably uniform results, and am fully persuaded that the fibres of the bladder and prostate, contrary to the received opinion, are curvilinear, and in fact spiral, or, more properly, lemniscate. The fibres, with few exceptions, form figure-of-eight loops, and the loops are variously shaped, according as they are superficial or deep. The most external and the most internal loops are attenuated or drawn out, and in this respect resemble longitudinal or vertical fibres, the deeper or more central ones being flattened from above downwards, and resembling circular fibres. The loops from this circumstance are divisible into *two orders*, viz. an external and an internal, and these orders may be subdivided, the former into *three sets of external* loops, the latter into *three sets of internal* ones. An intermediate or central set of loops occurs between. The seven sets of loops (external, internal, and central) represent so many layers or strata more or less perfect, and are indicated as well by their direction as by their position in the vesical parietes, the first and seventh sets (the most external and the most internal) being feebly developed, and having a more or less longitudinal or vertical direction, the second and sixth sets consisting of stronger fibres, which cross at acute angles after the manner of an attenuated figure of eight, the third and fifth sets, which occur in strong flattened fasciculi, crossing at obtuse angles, or more obliquely as in a figure of eight flattened from above or expanded laterally. The fourth, or central layer, consists of figure-of-eight loops, so crushed down or flattened that they appear to form complete circles. The crossing, however, is readily made out when sought for, and occasions that reticulated structure so conspicuous in the central layer. The terminal expansions of the loops forming the other layers contribute to the formation of the fourth or central layer, particularly towards the apex and base, and this accounts for its greater thickness. The various sets of external and internal loops are directed towards the apex and base, and are distributed on the anterior, posterior, and lateral aspects respectively. The anterior and posterior fibres are most strongly pronounced, the lateral ones being rudimentary and less fully developed. As a result of this distribution, and because of the puckering occasioned by the constrictions which originally separate the bladder from the intestinal tube, the walls of the viscus are of

unequal thickness, the thickest portion corresponding to the cervix in the neighbourhood of the sphincter, the second thickest portion to the apex in the vicinity of the urachus, the third to the trigone, the fourth and fifth to the anterior and posterior walls, and the sixth and seventh to the right and left lateral walls *. The most external and most internal loops are confined principally to one or other of the aspects indicated; but the deeper or more central loops radiate and expand towards the apex and base, so that they come to embrace the entire circumference of the bladder in these directions. The expansion referred to is greatest towards the apex, and the aggregation of the terminal loops of the anterior and posterior fibres at the cervix (assisted by the lateral ones) form a well-marked sphincter in this situation. The sphincter is bilaterally symmetrical and oval in shape, the long axis being directed transversely, or from side to side, as represented at $m\,m'$, $y\,y'$ of fig. 11, Plate III., and $l\,y$ of diagrams 10 & 20, Plate V. The two sets of lateral fibres (Plate V. diagram 10, $z\,r, v\,s$) which assist in the formation of the sphincter, intersect the angles formed by the crossing of the anterior and posterior fibres, and render its aperture somewhat circular in appearance. This circumstance, taken in connexion with the fact that the fibres pursue a very oblique direction, has given rise to the belief that the fibres of the sphincter and neck of the bladder generally are circular fibres, which is not the case. The fibres of the sphincter are best seen by inverting the bladder and dissecting from within, or by making transverse sections of the prostatic portion of the urethra in the direction of the fundus (Plate IV. figs. 19 & 20, *m*). They are most strongly pronounced at the cervix, but are continued forward on the urethra, and backwards into the bladder. In the female they extend even to the meatus urinarius. The apex and base of the bladder are similarly constructed, and resemble in their general configuration the other portions of the vesical walls; *i. e.* they are composed of longitudinal or vertical, slightly oblique, oblique, and very oblique spiral fibres, which cross in all directions externally and internally (Plate IV. figs. 13, 14 & 15). The longitudinal or vertical, slightly oblique, oblique, and very oblique external and internal fibres at the base are continued forwards within the prostate to the membranous portion of the urethra and the external and internal surfaces of the corpus spongiosum (*vide* Cervices of figs. 1, 4 & 7, Plate III.). The coats of the urethra are therefore to be regarded as the proper continuation of the walls of the bladder in an anterior direction. The external or longitudinal, slightly oblique, oblique, and very oblique spiral fibres which form the three outer and the central or circular tunic of the bladder and urethra, are curiously enough repeated in the prostate of the male and the analogous structure in the female, so that this gland would seem to be composed chiefly of fibrous offsets from the longitudinal, slightly oblique, oblique, and very oblique or circular fibres in question. To understand the relations existing between the bladder, prostate, and urethra, it will be most convenient to regard the four outer layers of the bladder as splitting up at the neck of the viscus,

* The right and left lateral walls are strengthened by the plexuses of blood-vessels and nerves, and by the cellular and fibrous tissues which abound in these situations.

one-half of the longitudinal, slightly oblique, oblique, and very oblique or circular fibres going to the prostate (Plate V. diagram 8. 1′, 2′, 3′, 4′), the other to the external or outer part of the prostatic portion of the urethra (1, 2, 3, 4). That this is the true arrangement may be readily ascertained by making vertical, horizontal, and antero-posterior or transverse sections of the parts concerned. In such sections (proceeding from without inwards) we find, first, the longitudinal (Plate V. diagram 8. 1′), slightly oblique (2′), oblique (3′) and very oblique or circular fibres (4′) of the prostate; second, the longitudinal (1), slightly oblique (2), oblique (3), and very oblique fibres (4) of the external or outer half of the urethra; and third, the very oblique (4), oblique (5), slightly oblique (6) and longitudinal or submucous fibres (7) of the internal or inner half of the urethra. The longitudinal, slightly oblique, oblique, and very oblique fibres belonging to the outer half of the urethra occupy an intermediate or central position with regard to those of the prostate and inner half of the urethra, and form a partition or septum similar in many respects to the septum ventriculorum of the heart. It is just possible that the septum in either case is formed by a simple reduplication, the folding in the bladder occurring at the cervix, and taking the form of an intussusception from below upwards *. Mr. Hancock, in his work on Stricture (p. 14), states his belief that the outer coat of the bladder passes forwards on the outside of the prostate gland, and laterally and inferiorly joins the fibres derived from the inner coat in front of the gland to assist in forming the organic muscular covering of the membranous portion of the urethra; but my dissections show that the external fibres of the prostate (Plate IV. figs. 30 & 32, *w*; Plate V. diagram 7, *p*) and the internal or submucous fibres of the urethra (Plate IV. figs. 30 & 32, *r*; Plate V. diagram 7, *a*″) are altogether independent of each other, and are separated by a wide interval—the interval being occupied by the slightly oblique, oblique, and very oblique fibres peculiar to the prostate and urethra. The very oblique or circular fibres of the prostate (Plate IV. figs. 24 & 27, *o*) and urethra (*m*), as will be seen from this account, are likewise separated by a considerable interval. The interval is widest at the base of the gland (Plate IV. fig. 24, *m*, *o*), where the sphincter is most fully developed, and at the apex (fig. 27, *m*, *o*). Towards the centre of the prostate the circular fibres (Plate IV. figs. 25 & 26, *o*) of the gland curve in an upward direction into the veromontanum or caput gallinaginis (*r*), where they blend with the circular fibres of the urethra (*m*). I draw attention to these facts because, as has been stated, Hodgson†, Ellis‡, and other investigators are of opinion that the circular fibres of the prostate are identical with those of the bladder and urethra, which is contrary to my experience. The circular fibres of the prostate are for the most part not only widely removed from those of

* For an explanation of the manner in which the septum is formed in the heart see paper by the author "On the Arrangement of the Muscular Fibres in the Ventricles of the Vertebrate Heart," Phil. Trans. Part III. 1864, p. 464.

† The Prostate Gland and its Enlargement in Old Age. By Decimus Hodgson, M.D. Edin. Lond. 1856.

‡ *Op. cit.* p. 4.

the urethra, but they have, as was shown by Sabatier, separate axes—the circular fibres of the urethra being concentric to the canal of the urethra, and eccentric to the circular fibres of the prostate (Plate IV. fig. 24, *m*, *o*). The only fibres which can with accuracy be regarded as continuous with the circular fibres of the bladder, are the corresponding fibres of the urethra (Plate III. fig. 9, *m*, *n*). The various sets of fibres in the vesical parietes are elaborately interlaced, the most external or superficial ones being connected directly and indirectly with the slightly oblique external, the slightly oblique external with the oblique external, and the oblique external with the very oblique or central fibres. The very oblique internal fibres, on the other hand, are connected with the oblique internal, these in their turn being connected with the slightly oblique internal, and the slightly oblique internal with the longitudinal or vertical internal. In some instances the longitudinal external are connected directly with the longitudinal internal, and so of the slightly oblique, oblique, and very oblique external and internal fibres. The bladder, urethra, and prostate are bilaterally symmetrical, and the fibres composing them pursue something like seven directions, the fibres crossing with remarkable precision at wider and wider vertical angles as the centre of either is reached, as in the stomach and heart *. In fact the fibres of the bladder, stomach, and heart have a strictly analogous arrangement, and I am inclined to believe that functionally also they possess points of resemblance. Very similar remarks may be made regarding the structure and functions of the uterus.

From a careful examination of a large number of mammalian bladders, I am of opinion that fundamentally the fibres are arranged in two principal directions, viz. vertically or longitudinally (Plate IV. fig. 34 & 36, *s*), and transversely or circularly (*m*). In the primary or typical bladder the vertical fibres, particularly in the undistended condition, are grouped together, and form ridges which are raised considerably above the level of the transverse fibres. The ridges, two in number, run from the urethra anteriorly to the urachus and urethra posteriorly, and from side to side. The former bisects the bladder in an antero-posterior direction, the other laterally. As the urachus naturally disconnects the ridges at the apex of the bladder, they may be conveniently described as the anterior, posterior, and right and left lateral ridges. They are seen to advantage in the bladders of the Ox (Plate IV. fig. 36, *a b*, *o p*, *s*), Cat (Plate IV. fig. 38, *a b'*, *c d*, *o p*), Sheep, Roebuck, and Wombat, and map out the circular fibres into four distinct regions. The fibres constituting them are united to the circular ones by short oblique fibres (Plate IV. fig. 36, *m*), and it may be stated that the so-called longitudinal and circular fibres are, with few exceptions, the most strongly marked. This is precisely what we should expect if, as Baer and Rathke affirm, the bladder is formed originally from the intestinal tube. The ridges are not always persistent, and the disappearance of a ridge necessitates a higher degree of differentiation in the fibres themselves, *i. e.* it demands an increase in the number of oblique fibres. In the Ox, Sheep, and Pig the lateral ridges are but feebly developed, and in the Horse the posterior one has all but disappeared.

* See paper by the author "On the Arrangement of the Muscular Fibres in the Ventricles of the Vertebrate Heart," Phil. Trans. Part III. 1864.

In the Koala no posterior ridge can be discerned, but the remaining three, viz. the anterior and two lateral (Plate IV. fig. 34, *o p*, *s t*), are strongly pronounced. In the human and other bilateral bladders (to which my subsequent remarks more particularly apply) two ridges alone persist, viz. the anterior (Plate III. fig. 1, *a b*) and posterior (Plate III. fig. 6, *o*). They correspond with what has been described as the great anterior and posterior longitudinal bands of fibres, and during the distended state of the viscus have their height so greatly reduced by lateral stretching as scarcely any longer to deserve the name of ridges. They, however, have their homologues in bladders of a lower type, and occasion a thickening of the wall of the bladder anteriorly and posteriorly which cannot otherwise be easily accounted for. It is a curious fact, and not without interest as far as the comparative anatomy of the bladder is concerned, that traces of the fourfold arrangement alluded to above may not unfrequently be detected in the human bladder, particularly at the apex and base. In one specimen which I dissected and preserved, it is especially distinct (Plate IV. fig. 16, *a o*, *k l*; fig. 18, *b p*, *m n*).

Although it is usual to speak of the fibres constituting the muscular coats of the bladder as longitudinal and circular, it may be as well to state that, strictly speaking, those terms are inapplicable, the so-called longitudinal fibres for the most part curving and diverging either in an antero-posterior or lateral direction, and the circular ones representing the aggregate of terminal loops, or very oblique fibres crossing at very obtuse angles. The terms therefore have been retained in the text rather with a view to assimilating my description with that of previous writers, and because it is convenient to have an ideal standard of comparison than because of their correctness. The best standard by which to compare the direction of the fibres is a line drawn from the cervix of the bladder anteriorly to the urachus and cervix posteriorly, another being made to extend from the right side of the cervix to the urachus and left side. A third line may be drawn transversely, or at right angles to both.

It has likewise been customary to regard the fibres constituting the vesical parietes as consisting of layers, but here, again, it is necessary to explain that the strata of the anatomist find no exact counterpart in the bladder itself, the fibres rarely, if ever, occupying precisely the same plane and running exactly parallel. They moreover split up and become fused with each other, with corresponding or homologous fibres, and with fibres which are either superimposed or underlie them. The term layer, which has also been retained, is consequently used in a restricted sense.

In the subjoined account I make no distinction between the male and female bladder, the difference which exists between the two referring rather to shape and to the greater length of the urethra in the former than to the general arrangement of the fibres themselves. I have, moreover, taken my description from young and adult normal bladders, from a feeling that Bell, Sabatier, and other investigators have given undue prominence to certain fibres or sets of fibres from having dissected abnormally thickened or hypertrophied bladders. As mere verbal descriptions, however voluminous and precise, would fail to convey an adequate conception of the various combinations formed by the fibres

of the bladder, I have confined my remarks to elucidating the plan or general arrangement, and have trusted for minor details to the figures and diagrams which will, I trust, be found sufficiently numerous for this purpose.

EXTERNAL FIBRES.

First or superficial layer, consisting principally of longitudinal fibres.—When the bladder of a young adult has been distended and carefully divested of its blood-vessels, nerves, and cellular tissue, it is found to be bilaterally symmetrical, the fibres comprising its parietes pursuing complicated but definite directions.

On the anterior aspect a certain number on either side of the mesial line proceed in a nearly vertical direction from the cervix to the urachus, and have from this circumstance been termed longitudinal (Plate III. figs. 1 & 3, *a b*; Plate V. diag. 1, *a b*). Of these, some arise from the posterior surface of the pubes by means of the anterior true ligaments, and some from the upper or dorsal surface of the fibrous capsule investing the prostate (Plate IV. fig. 29, *a b*), a certain number proceeding from the dorsal surface of the urethra (*a*). Others (Plate IV. fig. 28, *a*) pass in a more or less horizontal direction through the gland, and in this manner reach the under or ventral surface (*c*) of the prostatic capsule to which they adhere, the greater number losing themselves in the glandular stroma (*f*). In the opposite direction, or towards the urachus, some of the fibres are continuous with the urachus itself, while others are inserted into the peritoneal fold investing the top of the bladder. The greater proportion curve over and become continuous with the vertical or longitudinal fibres posteriorly (Plate III. figs. 4, 5, 6 & 8, *o p*). The posterior longitudinal fibres in their turn are connected with the fibres of the compressor urethræ, the under or ventral surface of the fibrous capsule of the prostate (Plate IV. fig. 29, *o p*), and the ventral surface of the urethra (*w*). Of these, a certain number curve in an upward direction (Plate IV. fig. 28, *h i*) and pass through the gland (*f*) to reach the dorsal surface of the prostate. The anterior and posterior longitudinal fibres, as they appear on the dorsal and ventral surfaces of the prostatic portion of the urethra, are seen at *b* and *p* of figs. 1 & 4, Plate III. On the right and left lateral aspects of the bladder longitudinal or vertical fibres, similar to those occurring on the anterior and posterior aspects, can be detected (Plate IV. fig. 9, *a b*); and I regard their occurrence in these situations as favouring the idea that originally the bladder is formed from the intestine. The fourfold arrangement of the fibres, especially at the apex and base, is well seen at Plate IV. fig. 16, *a o*, *k l*; fig. 18, *b p*, *m n*. The lateral longitudinal fibres are attached to the fibrous capsule of the prostate on its right and left aspects, some continuing their course on the sides of the urethra (Plate III. figs. 7 & 8, *b*), while others pass through the gland transversely (Plate IV. figs. 33 & 35, *a c*), or become lost in its substance. Sabatier*, when speaking of the anterior longitudinal fibres, says that in some instances this layer is extended laterally, and that in such cases the internal border of the aponeurosis of the levator ani also serves for insertion.

* *Op. cit.*

The fibres which can with any degree of propriety be regarded as pursuing a longitudinal or vertical direction are comparatively few, and are confined to the anterior, posterior, or lateral surfaces. They are best seen in the bladders of the lower animals.

2nd. *External layer, consisting of fibres arranged in attenuated figure-of-eight loops.*—Returning to the anterior aspect, we observe that at a point about half an inch above the cervix the fibres diverge from the mesial line gradually and with great regularity in an upward and downward direction; they in fact cross each other, and form figure-of-eight loops (Plate III. figs. 1 & 2, *c d e f*), the more attenuated of which are nearest to the line in question. These loops are placed beneath the longitudinal fibres, and are so arranged that they include the urachus (*x*) and urethra (*b*) in their terminal portions. SABATIER*, as was explained, observed a similar looped arrangement, and described the fibres which embrace the urachus and urethra, and are continued on the anterior surface as *oval fibres*. He was not aware that the fibres crossed each other and formed figure-of-eight loops. If a single fibre were taken, it might be regarded as setting out from the left side of the urachus and running in a spiral direction from left to right downwards, until it reached the cervix, round which it curves to proceed in an opposite direction, or from right to left upwards. The course of the fibre in question is indicated at Plate V. diagram 1, *c d e f*. The looped fibres form a figure-of-eight patch or layer which extends from the apex to the base for a little distance on either side of the mesial line. On the posterior aspect the fibres likewise diverge from the mesial line (Plate III. figs. 4 & 5, *q t*). In this instance, however, the divergence and crossing is less obvious, owing to the greatly attenuated condition of the loops occasioned by the greater vertical measurement of the bladder posteriorly. In many cases those loops, or modifications of them, extend forwards upon the urethra and give rise to a series of slightly oblique fibres not formerly described. The oblique fibres referred to can also be traced in the prostate. A similar figure-of-eight looped arrangement of the fibres is discovered on the sides of the bladder. The four sets of fibres described extend in the direction of each other, and invest a considerable proportion of the surface of the bladder. They form the second layer.

3rd. *External layer, consisting of fibres arranged in figure-of-eight loops flattened from above or extended laterally.*—If the longitudinal and slightly oblique fibres forming the first and second external layers be removed from the anterior aspect, a third set of looped fibres, diverging still more decidedly from the mesial line and forming a more perfect figure-of-eight, is discovered (Plate III. figs. 1 & 2, *g h i j*). Those fibres which have a deeper position diverge from the mesial line and cross each other obliquely at a point about three-fourths of an inch above the cervix. They proceed from the left of the mesial line posteriorly, curve round the left side of the bladder in a spiral oblique direction, and cross the mesial line anteriorly at the point indicated. Continuing their downward course,

† *Op. cit.*

they curve round behind the cervix, where they alter their direction and are lost to view, They reappear on the anterior surface, recross the anterior mesial line, and wind round in an upward spiral direction until they reach the right of the mesial line posteriorly, where we began to trace them. Their course is given in Plate V. diagram 1, *g h i j*.

The fibres under consideration form a broad expansion on the upper third of the bladder posteriorly (Plate III. fig. 7, *g*). On the sides and anterior aspect (*g d*) they converge until they reach the anterior mesial line, where they cross each other, after which they again slightly expand in a backward direction to assist in forming the posterior half of the sphincter vesicæ (Plate III. fig. 4, *v w*). They constitute a patch or layer of considerable thickness. Their direction at the upper third of the bladder posteriorly, and at the posterior aspect of the cervix, is nearly transverse, owing to the large curves made by the terminal portions of the loops. In those situations they form, with incidental or accessory fibres which are developed between them, part of the so-called transverse or circular layer of the older anatomists. Turning to the posterior surface, a similar disposition of the fibres can be made out. Here, however, owing, as has been already explained, to the greater posterior measurement of the bladder, the looped arrangement is not so obvious (Plate III. figs. 4 & 6, *u v w x*). That the fibres diverge from the mesial line in an upward direction is at once apparent, but that they cross and diverge in a downward direction is not so evident. Sabatier* was of opinion that they did not cross, and has represented them as coming together and separating as in the italic letter *x*. The crossing, however, as I have abundantly satisfied myself, does occur. Its site corresponds to a point in the mesial line about two inches above the base of the prostate.

The external fibres forming the third layer or patch posteriorly may be briefly described. They proceed from the left of the mesial line anteriorly, and curve in a downward and backward spiral direction until they reach the point indicated. Continuing their downward course, they cross the median line posteriorly, and curve round on the cervix anteriorly, where they assist in forming the anterior half of the sphincter vesicæ (Plate III. fig. 1, *h i*). They reappear on the posterior surface, recross the posterior median line, and curve in an upward and forward spiral direction until they reach the right of the median line anteriorly whence they set out. Their course is traced in Plate V. diagram 3, *u v w x*.

The posterior fibres of the third layer in this manner form figure-of-eight loops like the anterior ones; the loops of either set being so arranged that the terminal portions of each appear either on the anterior or posterior surface. They are continued forwards upon the dorsal and ventral surfaces of the urethra (Plate V. diagram 8. 3), and likewise upon the dorsal and ventral surfaces of the prostate (3′). This disposition of the fibres imparts a highly symmetrical appearance to the bladder, the terminal loops being arranged in two sets at the apex (Plate IV. fig. 15) and cervix (fig. 17), rendering it strikingly bilateral in these directions. I am axious to be explicit on this point, as it

* *Op. cit.*

bears upon the true structure of the sphincter vesicæ, which has up till the present been regarded as consisting of circular fibres instead of two sets of very oblique spiral fibres intersecting each other at two fixed points, those points corresponding to the right and left aspects of the cervix.

I have chosen to speak of anterior and posterior looped fibres, but this description, as will readily be perceived, is purely arbitrary, the fibres which begin on the posterior surface curving round and crossing each other anteriorly and the reverse. The method followed has been suggested by the direction and the crossing of the fibres, as well as by the position of the fibres in the parietes; it so happening that those portions of the fibres which form the terminal loops occupy a deeper situation than that occupied by the same fibres where they cross. By considering the fibres as anterior which cross anteriorly, and *vice versâ*, we are enabled to compare and contrast the direction of the fibres on the anterior, posterior, and lateral aspects of the bladder without in any way obscuring or interfering with their continuity. As it is to the direction pursued by the fibres that we must look for an explanation of the manner in which the bladder contracts, the plan adopted has many advantages,

The anterior and posterior fibres of the third layer, whose upper terminal loops spread out on the upper third of the bladder anteriorly and posteriorly, and whose lower terminal loops converge to assist in the formation of the sphincter, form two twisted slings (Plate III. fig. 8, *h g*, *o q*), the influence exercised by which in dragging the summit of the bladder towards the cervix or fixed point must be very considerable. The anterior and posterior sets of fibres which spread out on the summit, in addition to being continuous upon themselves to form loops, are continuous with each other on the upper third of the lateral aspects of the bladder. In these situations they unite with considerable regularity, after the manner of a groined arch (Plate III. fig. 6, *q l*), so that they form a kind of hood or capsule, which envelopes the apex. The fibres of the anterior and posterior sets interchange slightly with the fibres which are above and beneath them.

Two sets of fibres corresponding in their essential features to the anterior and posterior sets of fibres just described, may by a little careful examination be detected on the sides of the viscus. The fibres in question are feebly developed when compared with the anterior and posterior ones; but their distribution and general configuration is the same. Thus, if we trace the fibres from the median line intersecting the left half of the bladder, we shall find that they wind round anteriorly in a downward spiral direction, and cross that which intersects the right half at a point nearly midway between the apex and fundus (Plate III. fig. 9, *q r h g*). Pursuing their downward spiral course, they curve round the left side of the fundus, and reverse their direction to reappear on the right side. They then proceed in an upward spiral direction, recross the mesial line of the right side, and curve round until they regain that on the left, thus completing the figure of eight. These two sets of lateral fibres spread out on the anterior and posterior aspects of the upper third of the bladder, their terminal loops confining them-

selves to the right and left sides respectively. They converge at the cervix to assist in forming the sphincter, as explained.

Fourth, or central layer, consisting of fibres arranged in figure-of-eight loops, crushed together to produce the maximum of lateral distention.—Returning, for a fourth time, to the anterior aspect, we discover a still deeper and more oblique set of fibres. These, like their predecessors, form figure-of-eight loops; the loops in this instance being flattened from above downwards, and from below upwards. Proceeding with the description as before, we trace the fibres from the left of the posterior median line round upon the left side (Plate III. fig. 1, *k*), then on the anterior aspect, then on the right side (*l*), and onward to the posterior of the cervix, where they reverse their course to proceed in an upward and very oblique spiral direction (*m n*). They ultimately reach the point from which they started, and in this way become continuous at the apex and base. Their course is indicated at Plate V. diag. 1, *k l m n*. These fibres spread out on the lower two thirds of the bladder posteriorly, and form a layer of great thickness. They thus complete, by their flattened terminal loops, the lower portion of the so-called circular layer on this aspect (Plate III. fig. 5, *y z*; fig. 12, *k l*). They converge on the sides, and on reaching the anterior mesial line at a point half an inch or so above the cervix, are plainly seen to cross each other. On the posterior aspect of the cervix they are crowded together, and are principally concerned in forming THE POSTERIOR LIP OF THE SPHINCTER VESICÆ (Plate III. fig. 4, *y y′*, *z z′*; Plate V. diagram 4, *z z z*, *y′ y′ y′*). Many of them are prolonged on the ventral aspect of the urethra (Plate III. fig. 9, *m*), especially its prostatic portion, while others proceed to the prostate itself (Plate V. diag. 8, *g g′*). Turning to the posterior aspect, a corresponding set of fibres is met with (Plate V. fig. 4, *y y′*, *z z′*). These fibres come from the mesial line anteriorly, and curve round on the left side in a downward and very oblique spiral direction until they reach the mesial line posteriorly. They then proceed to the right, and curve round the cervix anteriorly, so as to change their course, and return in an opposite and upward direction to where we began to trace them. These fibres are greatly developed, and in their turn spread out on the lower two thirds of the anterior aspect, to complete what was wanting of the circular layer in this direction (Plate III. fig. 3, *k l*). They converge at the apex anteriorly, and are largely concerned in the formation of THE ANTERIOR LIP OF THE SPHINCTER (Plate III. fig. 1, *k l m n*; Plate V. diagram 2, *m m′ m″*, *l l′ l″*). Many of them are continued forwards on the dorsum of the urethra, and form, with corresponding fibres found on the ventral aspect, the so-called circular layer of the prostatic and membranous portions of the urethra. The lower portions of the bladder, the sphincter, and the prostatic and membranous portions of the urethra are thus plainly bilateral.

Two sets of similar, though less fully developed fibres occur on the sides of the bladder (Plate III. fig. 9, *m n*), and contribute to the formation of the lower portion of the central layer, sphincter, and urethral canal in these directions. It will be evident from this description that the so-called central or circular layer is not composed of circular fibres having a uniform direction, as figured by SABATIER, ELLIS, and others, but of very oblique

spiral fibres crossing at very obtuse angles, mixed up with the greatly expanded terminal portions of the loops forming the several layers. It ought, however, to be mentioned that a certain number of incidental or accessory fibres is developed between the crossings formed by the very oblique fibres which confer upon the layer a certain degree of uniformity. The layer in question is seen anteriorly at Plate III. figs. 3 & 11, *k l*, posteriorly at figs. 5 & 12, *y z' k l*, and laterally at fig 9, *m n*. It is traced in outline at Plate V. diagram 2, *k n*, *m l*; diagram 4, *y z*; diagram 6, *k n*, *m l*, and diagram 10, *y l*. The fibres forming the great central layer are united to each other where they intersect; they also interchange fibres with the layers to the outside and inside of them.

INTERNAL FIBRES.

Comprising layers 5, 6, *and* 7 (*imperfect*).—If the central layer be removed, which, owing to its great thickness and the tenuity of the internal fibres, is a matter of difficulty, it will be seen that the fibres to the inside of it, or the internal fibres proper, are arranged very much in the same way as the external fibres already described. The internal fibres are best seen when the bladder is inverted and the dissection conducted from within. They are, as compared with the external fibres, rudimentary and scantily developed. They do not, however, pursue the simply longitudinal course usually attributed to them. On the contrary, their direction is varied as in the external fibres. Thus those occurring in the mesial line anteriorly (Plate III. fig. 10, *a b*) and posteriorly (fig. 12, *o o*, *p p*) are more or less vertical, while those to the outside of them or nearer the central layer, diverge from the line in question, and show a decided tendency to the looped arrangement (Plate III. fig. 10, *c d e f*); those still deeper making unmistakeable spiral curves (*g h i j*) analogous to those made by corresponding external fibres. The same remarks, if allowance be made for their more fragmentary condition, may be made regarding the course and distribution of the internal fibres occurring on the sides of the bladder. The various sets of internal fibres cross each other like the external ones, the more longitudinal fibres at acute angles, the more circular or deeper ones at obtuse angles. They are continued on the ureters and urethra, and in the latter situation, owing to the smaller space occupied by them, are more plentiful (Plate III. fig. 10, *b*). Their general distribution in the interior of the urethra is given in the section headed *trigone* further on. The internal fibres of the bladder in some instances are so straggling that they form a network of large meshes. They are united by accessory slips to corresponding external ones, and the external in some instances originate the internal as in the heart. The internal fibres are so delicate in comparison with the fibres of the great central layer (Plate III. fig. 12, *k l*), that in the hypertrophied bladder the circular ones tear them asunder so that they partially or altogether disappear.

Distribution of the external and internal fibres at the apex and fundus.—The various directions pursued by the external and internal fibres on the walls of the bladder generally are readily made out at the apex and fundus, both from without and from

within. In fact if a cylinder composed of external and internal longitudinal slightly oblique, oblique, and very oblique fibres be constricted at either end, the general scheme of the arrangement of the fibres at the summit and base is at once apparent. The longitudinal or vertical fibres, particularly the external ones, bend over and unite, to form a crucial arrangement, the anterior joining with the posterior and the lateral with each other (Plate IV. fig. 16, *a o*, *k l*; fig. 18, *b p*, *m n*). The slightly oblique and oblique fibres in like manner bend over and unite, those because of their obliquity occasioning a stellate arrangement, which causes at the apex a corresponding thickening of the wall (Plate IV. figs. 13 & 15, *x*), and at the cervix a thickening and funnel-shaped puckering, which largely contributes to the closure of the urethral orifice (Plate IV. figs. 14 & 17, 2, 2′). The very oblique fibres, because of the greater size of the loops formed by their junction, furnish what are known as the circular fibres, and are continued on the body of the viscus generally (Plate IV. figs. 13, 15, & 16, *k l*, and figs. 14, 17 & 18, *m n*). The circular fibres, which are plentifully developed at the cervix, where they contribute largely to the formation of the sphincter, occur to the outside of the internal stellate fibres, and, with the elasticity natural to the parts, are principally concerned in the closure of the urethral orifice. This orifice, it may be remarked, is as impervious as the urachus itself when the urine is not actually passing through it, a considerable degree of pressure being necessary, even in the dead bladder, to force a passage. As might be supposed from this explanation, the apex and base, if allowance be made for the apertures of the ureters and urethra and the expanded condition of the viscus in the latter direction, are structurally identical. This is particularly evident when the apex and base are rendered transparent, and compared by being held against the light. When viewed from within, the various sets of vertical, slightly oblique, oblique, and very oblique fibres can be made out without difficulty. The crossing of the oblique and very oblique fibres concerned in the formation of the central layer is especially evident. These fibres, in conjunction with the accessory fibres developed between them, form tolerably perfect circles or rings, which invest the summit and base, particularly that portion of the base which corresponds with the cervix (Plate IV. fig. 17, 2 2′). I draw attention to this arrangement because of the symmetry it everywhere secures, and because in no work with which I am acquainted has the arrangement of the fibres at the apex and base been either described or figured. The fibres in question are shown at Plate IV. figs. 13, 14, 15, 16, 17 & 18.

TRIGONE.

Uvula, verumontanum; ureters and urethra—closure of, &c.—The only points requiring further elucidation pertain to the ureters and urethra, and that triangular space which occurs between them familiarly known as the trigone (Plate V. diagram 7, *z v s*). The space referred to has received a large share of attention, partly on account of its surgical importance, and partly because many authors suppose that the fibres and tissues composing it are specially constructed, and have particular functions assigned to them.

Sabatier and Bell, it will be remembered, were of opinion that the trigone and luette are the most sensible parts of the bladder; and Bell* and Guthrie† agreed in assigning to those parts a separate and increased nervous supply. Morgagni‡, Santorini§, and Lieutaud, as was explained, described two fleshy bodies which run from the uretral orifices to the verumontanum, those bodies being subsquently, though wrongly, described by Bell‖ as separate muscles.

Without entering into too great detail, it may be stated in a general way that the fibres of the trigone are very similarly arranged to those of corresponding internal fibres anywhere else at the fundus (Plate IV. figs. 14 & 17, 2, 2′); the only difference being that they are more mixed up with fibrous tissue, the fibrous tissue causing a matting and thickening of the vesical parietes in this situation. The following account is intended to show how the ureters enter the bladder, and how the fibres of the trigone are continued into the uvula and median ridge of the female, and the caput gallinaginis or verumontanum of the male (Plate V. diagram 7, *s*); those ridges playing an important part in the closure of the urethra.

The ureters, as is well known, enter the walls of the bladder obliquely on its posterior aspect (Plate III. fig. 6, 2). They enter midway between the posterior longitudinal and lateral longitudinal fibres at a point an inch and a half or so from the mesial line, and about the same distance from the base of the prostate. They are crossed externally and internally by the longitudinal slightly oblique, oblique, and very oblique fibres of the bladder, from all of which they receive accessions (Plate IV. fig. 14). The very oblique fibres, which are by much the strongest, run nearly at right angles to the longitudinal fibres of the ureters. Those portions of the ureters (2, 2) which lay within the vesical parietes are therefore invested with fibres from the bladder, analogous to those surrounding the prostatic portion of the urethra. The ureters, in virtue of this arrangement, are more or less under the influence of the fibres of the walls of the bladder in their immediate vicinity, the longitudinal and slightly oblique ones tending to obliterate the uretral canals during contraction by the thickening they undergo, the oblique fibres plaiting above, beneath, and around, and closing them from without inwards or centripetally. The closure is aided by the elasticity of the parts and the great obliquity of the uretral canals, those portions of the parietes which correspond with the track of the canals, particularly where the ureters open, being exceedingly thin, and acting in those situations as a moveable partition or valve. The valve in question responds to the

* "Account of the Muscles of the Ureters, and their effects on the irritable states of the Bladder. By Charles Bell, Esq.," Med. Chir. Trans. vol. iii. 1812.

† On the Anatomy and Diseases of the Urinary Organs and Sexual Organs. By G. J. Guthrie, Esq., F.R.S. 3rd. edit. London, 1843.

‡ Morgagni, Adversaria, i. n. 9, Adversaria iii. Animadver xlii.

§ Observationes Anatomicæ, cap. x. sec. xxi.

‖ A Treatise on the Diseases of the Urethra, Vesica urinaria, Prostate, and Rectum. By Charles Bell, Esq., 3rd edit. with notes by John Shaw, Esq. London, 1822.

slightest pressure, and resembles in some respects that found at the mouths of sinuses and in the smaller veins*.

The ureters enter the bladder obliquely in a twofold sense, viz., from above downwards, and from without inwards with regard to the posterior mesial line, and from above downwards and from without inwards with regard to the walls of the bladder itself. The degree of obliquity varies according to the degree of distention. In the flaccid or undistended bladder the ureters are directed towards each other at a considerable angle (Plate IV. fig. 14, 2, 2), and the extent of wall traversed by them from the time they enter the bladder until they reach its interior, equals, as nearly as may be, half an inch. In the distended state, on the other hand, the ureters come together in a nearly straight line (Plate IV. fig. 18, 2, 2), and the extent of wall traversed is increased to three-fourths of an inch, or thereabouts. The openings of the ureters in the flaccid bladder are separated by an interval, which varies in different bladders, and in the same bladders according to the degree of distension. Usually it is about an inch and a quarter in the flaccid bladder, and from an inch and a half to two inches in the distended one, Although the openings of the ureters are thus widely apart, it does not follow that the ureters, or rather the muscular fibres composing them, terminate where the openings occur. On the contrary, the muscular fibres of the ureters are continued between the uretral openings, and are as strongly pronounced in the interior of the bladder as they are on the exterior and within the walls. There is in fact no breach of continuity in the muscular fibres of the ureters within the bladder, and the two ureters unite in the mesial line to form a strong loop or girder in which the viscus may be said to be suspended or slung. This arrangement prevents puckering of the coats of the bladder at the points where the ureters open, and secures to those portions of the ureters imbedded in the walls of the bladder a relative and definite position. The continuity referred to is best seen when the preparation is rendered transparent and held against the light. When so viewed the ureters (continued into each other) appear as a strong dark band, which is as distinctly pronounced between the orifices of the ureters as within the walls of the bladder itself (Plate IV. figs. 14, 17, & 18, 2, 2'; Plate V. diagram 7, *v z*). In addition to being continuous with each other, the fibres of the ureters, as was satisfactorily shown by Hodgson† and Ellis‡, are continuous with those of the neck of the bladder and the urethra. The fibres which connect the ureters with those investing the urethral canal, converge in a downward direction, those which are nearest the median line (Plate V. diagram 7, *a a'*) coming together and crossing at very acute angles (*c c*), those which are deeper coming together and crossing at wider angles (*g g*), the deepest having a nearly transverse direction, as in the so-called central layer

* *Vide* paper by the Author "On the Relations, Structure, and Functions of the Valves of the Vascular System in Vertebrata," Trans. Roy. Soc. Edin. vol. xxiii. part 3. p. 763.

† The Prostate Gland and its Enlargement in Old Age. By Decimus Hodgson, M.D. Edin. London, 1856.

‡ "An Account of the arrangement of the Muscular Substance in the Urinary and certain of the Generative Organs of the Human Body. By George Viner Ellis," Med.-Chir. Trans. vol. xxxix.

(*k k*). The superficial and median fibres are continued into, and are principally concerned in the structure of the uvula and verumontanum (*s*). The deeper oblique fibres, which also assist in forming those structures, are mixed up with the very oblique or circular fibres of the prostate (Plate IV. figs. 25 & 26, *n*). They converge towards and cross at the verumontanum as in the letter X, so that the sinus pocularis is surrounded by fibres which radiate in every direction. This arrangement is useful in maintaining the relative position of the glandular ducts which open at this point. The verumontanum, as will be seen from this description, is essentially a muscular structure. It however contains, as KOBELT pointed out, a small quantity of erectile tissue, and in this many of the fibres terminate. The uvula and median ridge in the female and the caput gallinaginis in the male are analogous in structure, and both are connected with the ureters at their junction in the median line. While, therefore, the ureters are continuous with and drag upon each other directly (Plate IV. diagram 7, *v z*), they are continuous with and drag upon the median ridge (*a'*) and verumontanum (*s*) indirectly. This is important, as the ureters act against each other, and the two together tend to elevate or raise the median ridge and verumontanum during contraction. The shape of the verumontanum, on which its uses to a certain extent depend, is that of an inverted pyramid, the base of the pyramid being turned towards the base of the prostate. Its narrow end is consequently directed downwards and forwards. It is attached by one side of the pyramid to the posterior wall of the prostatic portion of the urethra, the two sides which are free terminating in a well pronounced crest. As the prostatic portion of the urethral canal is triangular in form (Plate IV. diagrams 12, 13, 14, 15, 16, & 17) and fitted upon or to the verumontanum so closely that water cannot be passed even in the dead bladder without exercising a considerable degree of pressure, it is not difficult to perceive that in the living organism, when the parts are injected with blood, the obliteration must be very complete. The urine moreover by its own weight will tend to force the wedge formed by the verumontanum in a downward direction, the circular fibres of the sphincter and its own structure and connexions confining the wedging within certain limits. When the bladder contracts, the longitudinal fibres, which connect the verumontanum with the ureters where they meet in the mesial line, have the effect of elevating or withdrawing the wedge and thus assist in rendering the orifice of the urethra patent*. SABATIER speaks of the verumontanum as the gate-keeper of the prostatic portion of the urethra.

In giving this explanation of the action of the verumontanum, I am aware that the office hitherto assigned to it is that of checking the reflux of the seminal fluid into the bladder. The semen, however, is passed so seldom when compared with the urine, that this must be regarded as a secondary rather than a primary function. In the female, moreover, where no corresponding action can be performed, a median ridge or modified verumontanum can be detected. The uneasy feeling experienced by the patient when

* The longitudinal fibres referred to are fully an inch and a half in length, so that their elevating power must be very considerable.

the catheter is being passed through the prostatic portion of the urethra, and which is not felt by the female, is owing probably not so much to the supposed heightened sensibility of the parts as to mechanical obstruction and entanglement. That the pain in question is referable to the region of the verumontanum and not to the trigone, as is commonly believed, seems certain from a fact first stated by GUTHRIE*, that in the healthy bladder even when moderately distended the triangular space descends so as to be beyond the reach of the catheter. The extreme sensitiveness of the trigone in disease, or when irritated by the presence of a stone, is moreover no proof of its increased sensibility in the normal condition of the parts. If the trigone, as SABATIER, BELL, and others affirm, be so delicately sensitive, it is difficult to understand how the urine, which naturally collects in the neck of the bladder, is not expelled almost as soon as it is received. BELL and GUTHRIE lay considerable emphasis upon the unusually large supply of nerves to this part, but repeated and very careful dissections of the nerves of the bladder, not only in man but in the ox, sheep, monkey, and other animals, induce me to dissent from their views. The supply to the trigone in no way exceeds that to the parts surrounding the neck of the bladder generally. The nerves and likewise the blood-vessels are more numerous at the neck and fundus than they are towards the apex and higher up, but the distribution is uniform, and consists of a complete network, which extends itself over the external and internal surfaces and within the walls. The network, I may observe, is remarkable for the immense number of ganglia it everywhere displays, these in some instances, particularly on the sides of the bladder, being exceedingly large. In the ox I have found them of the size of a small millet seed, and in man and in the monkey they are correspondingly developed.

Muscles of BELL.—The muscular fibres which run between the orifices of the ureters and urethra, and which form the lateral boundaries of the trigone, had undue prominence assigned them by BELL†, who described them as separate structures under the title of muscles of the ureters. These muscles, he says, are inserted by tendons into the middle lobe of the prostate, and their function is to preserve the due obliquity of the orifices of the ureters. They have, however, neither the insertion nor function indicated. They are continued into the verumontanum and urethra, and apart from the other fibres of the trigone have no existence. The obliquity of the ureters, moreover, as has been shown, is primarily secured by the fibres of the ureters being continued into each other within the bladder. Sir CHARLES seems to have been misled by dissecting hypertrophied bladders from without, and by supposing that the coat of the bladder which contracts is on the outside of the oblique passages of the ureters, an arrangement necessitating, as he thought, some counteracting power on the inside to draw down the

* On the Anatomy and Diseases of the Urinary Organs and Sexual Organs. By G. J. GUTHRIE, F.R.S. 3rd edit. Lond. 1843, p. 6.

† "Account of the Muscles of the Ureters and their effects on the irritable states of the Bladder. By CHARLES BELL, Esq." Med. Chir. Trans. vol. iii. 1812.

uretral orifices. The ureters, however, as the reader is aware, are in reality situated within the walls of the bladder, and are grasped alike by the external and internal fibres (Plate V. figs. 14 & 17, 2, 2'), an arrangement which dispenses with the necessity for special muscles. What therefore was delegated to separate structures is more conveniently and effectively performed by the fibres of the bladder itself.

The longitudinal and oblique fibres occurring between the muscles of Bell, and which enter principally into the formatian of the uvula and median ridge of the female and the verumontanum of the male, are continued forwards on the urethra of the latter. They are variously disposed. At the apex of the prostate they diverge and bifurcate to a greater or less degree. On the membranous portion of the canal some are oblique and some straight. Further forwards they diverge and then converge to form an oval patch corresponding to the posterior third of the spongy portion; they subsequently diverge in the direction of the glans penis, where they spread out to embrace the fossa navicularis. Here they apparently terminate in loops.

RECAPITULATION.

The points which I have sought more especially to establish in the present memoir are the following:—

I have endeavoured to show that the fibres of the bladder are spiral continuous fibres arranged for the most part in the form of figure-of-eight loops, the loops being directed towards and embracing the urachus and urethra respectively.

The fibres distribute themselves on the anterior, posterior, and lateral surfaces, and are divisible into seven layers or strata, which are more or less perfect, viz. three external, a fourth or central, and three internal. The fibres of the first and seventh layers (the most external and most internal) pursue a nearly vertical direction and are feebly developed; the fibres of the second and sixth layers, which are stronger and occupy a deeper situation, running in a slightly oblique spiral direction and crossing at acute angles; those of the third and fifth layers, which are still stronger and deeper than any of the others, running in a spiral oblique direction and crossing at obtuse angles. The fibres of the fourth or central layer pursue a very oblique spiral course, and cross at such obtuse angles as to have been up till the present regarded as circular fibres. The fibres in this manner increase in strength and in obliquity, both from without and from within, and form by their interlacings a structure remarkable alike for its complexity and its beauty.

The apex and base are structurally identical, and consist of longitudinal, slightly oblique, oblique, and very oblique or circular external and internal fibres, crossing and interlacing as in the other portions of the vesical parietes.

The longitudinal or vertical fibres have a crucial arrangement at the apex and base, and the slightly oblique ones are drawn together at the urachus and cervix by the constrictions which in the embryo separate the bladder from the allantois and urethra. This stellate arrangement occasions a thickening of the walls of the bladder at the points indicated, and renders the bladder impervious in both directions; the urethra, unless

when the urine is actually passing through it, being perfectly closed. This is interesting, as it shows how an orifice patent only at long intervals assimilates itself to one, viz. the urachus, closed at birth. The closure of the urethra is favoured by the contraction of the very oblique or circular fibres forming the sphincter, and by the prominence of the uvula vesicæ (luette vésicale) and median ridge in the female and the caput gallinaginis or verumontanum in the male. The longitudinal, slightly oblique, oblique and very oblique external and internal fibres are continued into the prostatic portion of the urethra, so that the urethra is to be regarded as the proper continuation of the bladder in an antero-posterior direction. It ought, however, to be mentioned that the four outer layers of the bladder split up or bifurcate at the cervix, the one half going to the external or outer half of the urethra, the other to the prostate. There is consequently no portion of the bladder, urethra, or prostate in which longitudinal, slightly oblique, oblique, and very oblique or circular fibres may not be found.

The longitudinal fibres of the prostate and urethra are separated by a considerable interval, and the very oblique or circular fibres, which are widely distinct and have separate axes at the cervix where the sphincter is most fully developed, curve into and are blended with each other in the region of the verumontanum. This is important, as it shows how the sphincter may act independently of the prostate, and the reverse.

The very oblique or circular fibres have been specially described from the fact of their entering largely into the formation of the bladder, urethra, and prostate, and because they are principally concerned in the formation of the sphincter.

The sphincter vesicæ, the existence of which has been doubted, is composed of an anterior and posterior set of oblique and very oblique or circular fibres which is largely developed, and by a right and left lateral set which is accessory and less fully developed.

The fibres of the sphincter are continuous with the oblique and very oblique spiral fibres of the urethra and bladder generally, and this circumstance, more than any other, has induced anatomists to deny its presence. As well, however, might we argue against the existence of a sphincter in the stomach or rectum, for in both of those cases, as is well known, there is continuity of structure. The fibres of the trigone are similarly arranged to the other internal fibres at the fundus, the very oblique or circular ones passing across between the uretral orifices to blend with the fibres of the ureters themselves, while the olique, slightly oblique, and vertical pass in a downward direction and converge prior to reaching the verumontanum, where they cross, and for the most part terminate. The verumontanum is thus directly connected with the fibres of the trigone, and indirectly with the internal fibres of the cervix generally. During the distended or passive condition of the bladder it acts in a downward direction as a mechanical wedge, and with the aid of the sphincter completely occludes the passage of the urethra. In the active state, or when the urine is being expelled, the verumontanum is elevated or withdrawn by the contraction of the more vertical fibres of the trigone, the other vertical fibres of the fundus acting in harmony and elevating, and in this manner opening up, dilating, or expanding the funnel-shaped cavity within the

sphincter, the sphincter relaxing simultaneously and affording a clear channel for the escape of the fluid contents of the bladder*.

The ureters enter the vesical parietes at a very obtuse angle, and the angle increases according to the degree of distention of the bladder. They receive accessions of fibres from the longitudinal, slightly oblique, oblique, and very oblique external and internal fibres in their vicinity, and are continued upon each other within the bladder in the form of a strong transverse band. The transverse band which connects the ureters together within the bladder, or between the uretral orifices, is equal in volume to the ureters themselves within the vesical parietes. It is best seen when the base of the bladder is detached and held against the light, and seems to be formed by a partial obliteration of the uretral tubes.

The uretral canals seek the internal surface of the bladder even more obliquely than the ureters, and the inner surfaces of the ureters become so thin, particularly towards the uretral orifices, that they act mechanically as moveable partitions or valves, as in the smaller veins. The canals of the ureters are consequently closed, partly by the contractions of the muscular walls, and partly by the mechanical pressure exercised by the urine about to be expelled.

From the foregoing *résumé* it will be evident that the various sets of external and internal fibres forming the bladder, urethra, and prostate are arranged so as to coordinate each other, the loops formed by the anterior fibres crossing each other at more or less acute angles according to their depths, the anterior fibres, as a whole, crossing the posterior or homologous fibres as a whole. While, therefore, the fibres, in virtue of their twisted looped arrangement, coordinate each other individually, the aggregation of the fibres in any one region coordinate a similar aggregation of fibres at an opposite point, the anterior fibres, *e. g.*, acting on the posterior, and the right lateral upon the left lateral†. This arrangement, which is productive of great strength, ensures that the external and internal fibres shall act in unison or together, and fully explains the views of the older anatomists, who described the bladder as consisting of fibres crossing in every direction, and forming an intricate network. It likewise accords with the more modern opinion, that the fibres of the bladder may be divided into strata or layers.

It is difficult to estimate the precise effect which the twisted looped arrangement of the fibres may have on the contraction of the bladder; but the fibres are disposed so

* The structures which take part in the expulsion of the urine have been tabulated by Sir Charles Bell as follows:—"The proper internal sphincter of the bladder, the compressor prostator, the levator ani, the levator or compressor urethræ of Mr. Wilson, the ejaculator seminis, the internal and oblique perinal muscles. These, he says, are of the class of sphincter muscles, their opponents being the detrusor urinæ or muscular coat of the bladder (and in consent with it), the abdominal muscles and diaphragm." This author, it will be observed, makes no mention of the verumontanum.

† The principle here foreshadowed seems to attain its full development in the voluntary system of muscles where the extensors coordinate the flexors, the abductors the adductors, the pronators the supinators, &c.

symmetrically, and so nicely balanced as regards length, strength, and direction, that I am of opinion the order of contraction is very precise and well defined. I am further inclined to believe that the fibres of the several layers contract towards certain points, the more longitudinal anterior, posterior, and lateral fibres contracting from above downwards in the direction of the urethra so as to approximate the apex and fundus, the slightly oblique, oblique, and very oblique spiral fibres contracting towards the points where they cross each other, viz. towards the anterior, posterior, and right and left lateral raphe. That this centripetal and downward action of the oblique fibres towards the points of intersection takes place is rendered probable by the fact, that in the contracted bladder the anterior, posterior, and lateral ridges (where they exist) are thrown into bold relief*, the sides of the viscus in some instances coming together so completely that their mucous surfaces adhere. In such cases, if any urine be present, it is, as a rule, confined to the immediate vicinity of the uretral orifices, and not diffused throughout the cavity of the bladder generally, as it would most likely be if there were not a strong persistent lateral action.

Explanation of Plates.

PLATE III.

Fig. 1. Anterior view of young adult male bladder, showing longitudinal (*a b*), slightly oblique (*c d e f*), oblique (*g h i j*), and very oblique (*k l m n*) spiral figure-of-eight fibres, as seen in layers 1, 2, 3, & 4.
x. Urachus.

Fig. 2. Anterior view of adult female bladder. Shows slightly oblique (*c d e f*) and oblique (*g h i j*) spiral figure-of-eight fibres, with a few oval fibres, as observed in layers 2 & 3.
x. Urachus.

Fig. 3. Anterior view of adult female bladder (walls rendered transparent). Shows longitudinal and slightly oblique spiral figure-of-eight fibres mixed up (*a b*), as seen in layers 1 & 2. Likewise the very oblique spiral fibres commonly regarded as circular (*k l*), forming the fourth or central layer.

Fig. 4. Posterior view of young adult male bladder, showing longitudinal (*o p*), slightly oblique (*q t*), oblique (*u v w x*), and very oblique (*y y'*, *z z'*) spiral figure-of-eight fibres, as seen in layers 1, 2, 3, & 4.
2, 2. Portions of ureters.

Fig. 5. Posterior view of adult female bladder (transparent). Shows longitudinal (*o p*), slightly oblique (*q t*), and very oblique or circular fibres (*y z*), as seen in layers 1, 2, & 4.

Fig. 6. Posterior view of adult male bladder. Shows longitudinal (*o*), slightly oblique

* *Vide* Plate IV. figs. 34, 36, & 38, *a b*, *o p*, *s t*.

($q\,t$), oblique ($u\,v\,w\,x$), and very oblique or circular fibres (y), as seen in layers 1, 2, 3, & 4.

2, 2. Portions of ureters.

Fig. 7. Left lateral view of young adult male bladder, showing longitudinal ($a\,b$, $o\,p$), slightly oblique ($c\,d$), oblique ($g\,i\,h$), and very oblique ($k\,l\,m\,n$) spiral figure-of-eight fibres, as seen in layers 1, 2, 3, & 4.

x. Urachus.

Fig. 8. Right lateral view of adult male bladder, showing longitudinal ($a\,b$, $o\,p$), slightly oblique (q), oblique ($g\,g$, $h\,h$), and very oblique spiral fibres (n), as seen in layers 1, 2, 3, & 4.

2. Portion of ureter.

x. Urachus.

Fig. 9. Left lateral view of adult male bladder (transparent), showing longitudinal($a\,b$), oblique ($q\,q$, $r\,r$, $h\,h$, $g\,g$), and very oblique or circular fibres ($m\,n$), as seen in layers 1, 3, & 4.

2. Portion of ureter.

x. Urachus.

Fig. 10. Anterior view of adult male bladder inverted, showing longitudinal ($a\,b$), slightly oblique ($c\,d\,e\,f$), oblique ($g\,h\,i\,j$), and very oblique (k) spiral figure-of-eight fibres, as seen in layers 7, 6, 5, & 4. The internal fibres are fewer in number and more rudimentary than the external ones, but their directions, as a little careful examination will show, are the same.

x. Urachus inverted.

Fig. 11. Anterior half of adult male bladder, seen from within (transparent). Shows longitudinal (a) and very oblique or circular fibres, forming the fourth or central layer ($k\,l$); also the continuations of those fibres in a downward direction towards the cervix, where they are arranged in two sets ($m\,m'$, $y\,y'$), and are principally concerned in the formation of the sphincter vesicæ.

x. Urachus, from within.

Fig. 12. Posterior view of adult male bladder inverted. Shows longitudinal ($o\,o$, $p\,p$) and very oblique or circular fibres ($k\,k$, $l\,l$), as seen in layers 7 & 4.

PLATE IV.

Fig. 13. Apex of adult male bladder placed upon its posterior surface (transparent). Shows longitudinal ($a\,o$), slightly oblique ($e\,f\,q\,t$), oblique ($g\,j\,u\,x$), and very oblique or circular fibres ($k\,l$), similar to those occurring on the walls of the bladder generally. The very oblique fibres are arranged in two sets ($k\,l$), as at the fundus. Compare with fibres marked $m\,m'$, $y\,y'$ in fig. 11, Plate III.

Fig. 14. Fundus and cervix of adult female bladder placed on its posterior surface (transparent). Shows longitudinal ($b\,p$), slightly oblique ($d\,e$, $r\,s$), oblique

($h\,i\,v\,w$), and very oblique ($m\,n$) fibres; the latter curving round the urethra (s) in two sets (m and n), and contributing largely to the formation of the sphincter, which is bilaterally symmetrical. The sphincter receives accessions of fibres from the ureters (2, 2').

2, 2. Ureters penetrating the walls of the bladder and appearing continuous within it as a strong transverse band.

Fig. 15. Apex of adult male bladder placed on its posterior surface, seen from within, the converse of fig. 13 (transparent). Shows longitudinal ($a\,o$), slightly oblique ($e\,f\,q\,t$), oblique ($g\,j\,u\,x$), and very oblique fibres ($k\,l$).

x. Thickened stellate patch of fibres corresponding to attachment of urachus, and occasioned probably by the constriction which originally separates the bladder from the allantois.

Fig. 16. Apex of adult male bladder placed on its posterior surface (transparent). Shows anterior (a), posterior (o), and right (k) and left (l) longitudinal fibres arranged in a crucial form, with the urachus (x) as the central point, and in a minor degree the slightly oblique ($c\,f\,q\,t$), oblique ($g\,j\,u\,x$), and very oblique ($k\,l$) fibres seen in fig. 13. Compare with similar arrangement in fig. 18, which represents the fundus and cervix of the same bladder.

Fig. 17. Fundus and cervix of adult female bladder placed on its posterior surface, seen from within (tranparent). Shows longitudinal ($b\,p$), slightly oblique ($d\,e\,r\,s$), oblique ($h\,i\,v\,w$), and very oblique or circular ($m\,n$) fibres, but principally the longitudinal and circular; also the continuity of the ureters with each other in the mesial line, and with the fibres of the uvula, &c. It likewise shows the trigone (2, 2) and the funnel-shaped thickening occurring at the cervix, occasioned probably by the constriction which separates the bladder from the urethra.

Fig. 18. Fundus and cervix of adult male bladder placed on its posterior surface (transparent). Shows anterior (b), posterior (p), and right (m) and left (n) longitudinal fibres arranged in a crucial form with the prostate (z) as a centre; and in a minor degree, the slightly oblique ($d\,e\,r\,s$), oblique ($h\,i\,v\,w$), and very oblique or circular ($m\,n$) fibres seen in fig. 14. Compare with similar arrangement in fig. 16, which represents the apex of the same bladder.

2 2'. Ureters penetrating the walls of the bladder and appearing continuous within it as a dark transverse band.

Fig. 19. Transverse section of prostate and urethra at cervix (male).

m. Very oblique or circular fibres of urethra forming the sphincter. Compare with $m\,m'\,m''$, $l\,l'\,l''$ of diagram 2, and $z\,z\,z$, $y'\,y'\,y'$ of diagram 4, Plate V.

Fig. 20. Transverse section of prostate and urethra $\frac{1}{4}$ of an inch from the cervix (male).

m. Very oblique or circular fibres of the prostatic portion of the urethra. Compare with $m\,m'\,m''$, $l\,l'\,l''$ of diagram 2, and $z\,z\,z$, $y'\,y'\,y'$ of diagram 4, Plate V.

x. Oval band of fibres surrounding the ducts of the vesiculæ seminales.

Fig. 21. Transverse section of prostate and urethra $\frac{1}{2}$ an inch from the cervix (male).

m. Very oblique or circular fibres of the urethra blending with similar fibres belonging to the prostate (*o*).

n. Fibres belonging partly to the urethra and partly to the prostate, radiating in the substance of the gland from the verumontanum (*r*) as a central point.

x. Circular band of fibres embracing the ducts of the vesiculæ seminales.

Fig. 22. Transverse section of female urethra near the cervix, showing the very oblique or circular fibres (*m*) constituting the sphincter vesicæ.

y. Opening for vessels.

ff'. Upper surface of vagina.

Fig. 23. The same, nearer the meatus urinarius.

m. Very oblique or circular fibres of the urethra.

n. Ditto, in subjacent tissue.

zf. Upper and under surface of urethra.

y. Opening for vessels.

Fig. 24. Transverse section of prostate and prostatic portion of urethra at base of gland (male).

m. Very oblique or circular fibres of urethra where sphincter is most fully developed.

o. Corresponding fibres of the prostate. Those fibres are distinct from each other at this point, and are separated by a considerable interval.

x. Oval band of fibres surrounding ducts of vesiculæ seminales.

Fig. 25. Transverse section of prostate and prostatic portion of urethra rather more than $\frac{1}{4}$ of an inch from the base (male).

m. Very oblique or circular fibres of urethra.

o. Very oblique or circular fibres of prostate curving into the verumontanum (*r*), where they blend with the circular and other fibres of the urethra (*m*). The relation existing between the urethra and prostate in this and the succeeding section is of the most intimate description.

Fig. 26. A similar section, rather more than $\frac{1}{2}$ an inch from the base (male).

m. Very oblique or circular fibres of the urethra blending with corresponding fibres belonging to the prostate (*o*).

n. Fibres which belong partly to the prostate and partly to the urethra, and which radiate from the verumontanum (*r*) as a centre.

Fig. 27. Another and similar section at the apex (male).

m. Very oblique or circular fibres of the urethra.

o. Corresponding fibres of the prostate. In this section, as in that represented at fig 24, a considerable interval occurs between the two sets of circular fibres.

g g. Under surface of prostate.

Fig. 28. Vertical section of fundus of bladder and prostate (male). Shows intimate relation existing between bladder and prostate, and how some of the longitudinal fibres from the anterior wall (*a*) proceed to the dorsal surface of the gland (*i*), some passing through it (*f*) and reaching its ventral surface (*c*). It also shows how some of the longitudinal fibres from the posterior wall (*h*) pass on to the ventral surface (*x*), while others curve in an upward direction to reach the dorsal surface (*i y*).

Fig. 29. A similar vertical section in the vicinity of the urethra, exhibiting a still closer relation of the parts (male).

a. Longitudinal fibres from anterior wall of bladder proceeding to dorsum of prostate (*b*) and dorsal surface of urethra (*w*).

o. Longitudinal fibres from posterior wall of bladder proceeding to ventral surface of prostate (*p*) and ventral surface of urethra (*w*).

Fig. 30. A third and similar vertical section through centre of prostate and urethra (male). Shows anterior longitudinal fibres diverging at cervix (*r*) and going to dorsum of prostate (*w*) and dorsal surface of urethra.

s. Internal longitudinal submucous fibres continued into the urethra. These fibres are independent of those marked (*r*).

t. Posterior longitudinal fibres going to ventral surface of urethra.

v. Substance of prostate in which is to be found slightly oblique, oblique, and very oblique fibres.

Fig. 31. Vertical section of the parts at the neck of the bladder in the adult female.

a. Longitudinal fibres from anterior wall, bifurcating, some proceeding to dorsum of urethra (*b*), others in a downward direction (*l*).

o. Longitudinal fibres from posterior wall proceeding to the ventral surface of urethra (*p*), and in an upward direction (*l*).

m. Very oblique or circular fibres surrounding urethra.

Fig. 32. Vertical mesial section through cervix of bladder and urethra in adult female. The lettering and description corresponds to that given under fig. 30.

Fig. 33. Horizontal section of cervix and prostate in adult male.

a. Longitudinal fibres from right side of bladder, bifurcating, some passing to right side of prostate (*b*), others passing in a lateral direction to left side of bladder (*c*).

c. Longitudinal fibres from left side of bladder proceeding to left side of prostate (*d*), and to right side of bladder (*a*). These fibres represent certain of the terminal loops.

s. Oblique passage of urethra.

Fig. 34. Right lateral view of bladder of Koala, showing how in some of the lower animals the longitudinal (*a b*, *o p*, *s t*) and very oblique or circular fibres (*m*) predominate, and how the longitudinal fibres are thrown into ridges during contraction.

Fig. 35. Horizontal section of cervix and prostate in adult male.

a. Longitudinal fibres from right lateral wall of bladder passing across to left lateral aspect of prostate (*d*).

c. Longitudinal fibres from left wall of lateral bladder passing to right lateral aspect of prostate (*b*).

m. Some of the terminal loops of the posterior figure-of-eight fibres.

o. Oblique passage of urethra.

Fig. 36. Right lateral view of heifer's bladder in a state of contraction. Shows anterior (*a b*) and posterior (*o p*) longitudinal fibres raised in the form of ridges. The lateral ridge (*s*) is less strongly marked than those marked *a b*, *o p*.

m. Oblique and very oblique or circular fibres mixed up with the longitudinal.

Fig. 37. Horizontal section of cervix and prostate nearer centre of gland (male).

a. Longitudinal fibres from right lateral wall of bladder proceeding to right side of prostate (*b*) and across to left side of bladder (*c*).

c. Longitudinal fibres from left lateral wall of bladder proceeding to left side of prostate (*d*) and across to right side of bladder (*a*).

n. Peculiar stellate arrangement of fibres.

Fig. 38. Posterior view of cat's bladder in the contracted state, showing longitudinal fibres (*a b*, *c d*, *o p*) elevated into ridges; the central posterior ridge (*o p*) having oblique fibres (*g t*) proceeding from beneath it.

PLATE V.

Diagram 1 represents in outline the various sets of fibres occurring on the anterior aspect of the bladder, as seen in layers 1, 2, 3, & 4.

a b. Longitudinal or vertical fibres forming layer 1.

c d e f. Slightly oblique spiral figure-of-eight fibres embracing urachus (*x*) and urethra (*b*) posteriorly and forming layer 2.

g h i j. Oblique spiral figure-of-eight fibres embracing upper third of bladder and lower portion of cervix posteriorly and forming layer 3.

k l m n. Very oblique spiral figure-of-eight fibres embracing lower two-thirds of bladder and upper portion of cervix posteriorly, and forming the fourth or central layer. The fibres of this layer enter principally into the formation of the sphincter, and, contrary to the received opinion, cross each other at very obtuse vertical angles.

Diagram 2 shows the same as diagram 1, and, in addition, the manner in which the sphincter and fourth or circular layer is formed posteriorly.

g j. Terminal expansion or loop representing the spiral oblique fibres which spread out on the upper third of the bladder posteriorly, and assist in forming the central, transverse, or circular layer in this direction. Its

concomitant or companion loop embraces the cervix posteriorly, and assists in forming the posterior lip of the sphincter vesicæ.

k n, *k′ n′*, *k″ n″*. Terminal expansions or loops representing very oblique spiral figure-of-eight fibres, forming the lower two-thirds of the fourth or central layer posteriorly. Their companion loops occur on the posterior aspect of the cervix, and are principally concerned in the formation of the posterior lip of the sphincter (*m l*, *m′ l′*, *m″ l″*). The sphincter and the other portions of the fourth or central layer, as will be seen from this explanation, are not composed of circular fibres as is generally believed.

Diagram 3 represents the various sets of fibres occurring on the posterior aspect of the bladder, as seen in layers 1, 2, 3, & 4.

o p. Longitudinal or vertical fibres forming layer 1.

q r s t. Slightly oblique spiral figure-of-eight fibres embracing urachus and urethra anteriorly, and forming layer 2.

u v w x. Oblique spiral figure-of-eight fibres embracing upper third of bladder and lower portion of cervix anteriorly, and forming layer 3.

y y′ z z′. Very oblique spiral figure-of-eight fibres embracing lower two-thirds of bladder and upper portion of cervix anteriorly, and forming the fourth or central layer.

Diagram 4 shows the same as diagram 3, and, in addition, the manner in which the sphincter and fourth or central layer is formed anteriorly.

u x. Terminal expansion or loop representing the spiral oblique fibres which spread out on the upper third of the bladder anteriorly, and assist in forming the central, transverse, or circular layer in this direction. Its companion loop embraces the cervix anteriorly, and assists in forming the anterior lip of the sphincter.

y′ z, *y′ z′*, *y″ z″*. Terminal expansions or loops representing the very oblique spiral figure-of-eight fibres, forming the lower two-thirds of the fourth or central layer anteriorly. Their companion loops occur on the anterior aspect of the cervix, and are principally concerned in the formation of the sphincter, *z y′*, *z y′*, *z y′*.

Diagram 5 represents the various sets of fibres occurring on the left lateral aspect of the bladder, as seen in layers 1, 2, 3, & 4.

a b, *o p*. Anterior and posterior longitudinal fibres, as seen in layer 1.

c d e, *s t*. Slightly oblique spiral figure-of-eight fibres embracing urachus (*x*) and urethra, as seen in layer 2.

g h h′, *i i′ j*. Oblique spiral figure-of-eight fibres spreading out on upper third of right side of bladder and right side of sphincter, as seen in layer 3.

k l m n. Very oblique spiral figure-of-eight fibres embracing lower two-thirds of right side of bladder and right side of sphincter.

Diagram 6 represents the manner in which the sphincter and the fourth or central layer is formed on the right side of the bladder.

k n, *k n*, *k n*. Terminal expansions or loops formed by the very oblique spiral figure-of-eight fibres which spread out on the right side of the bladder and form the fourth or circular layer in this situation. Their companion loops occur on the left side of the cervix, and contribute to the formation of the sphincter in this situation (*m m m*, *l l l*).

Diagram 7. Horizontal section of fundus, cervix, prostate, and urethra of adult male. Shows relation of ureters to each other, to fibres of trigone, verumontanum, &c.

v, *z*. Ureters continued into each other at *a*, and connected more or less directly with the longitudinal (*a'*), slightly oblique (*c c*), oblique (*g g*), and very oblique (*k k*) fibres of the trigone. Those fibres converge towards, and in many instances cross at the verumontanum (*s*), where they terminate. A considerable number, however, are continued downwards on the membranous portion of the urethra (*a''*).

m, *m'*. External half of right and left wall of bladder splitting up (*n*, *n'*) a certain proportion of the fibres (*p p'*) going to the prostate gland (*q q'*); the greater number to the urethra (*o o'*). See diagram 8.

Diagram 8. Vertical section of neck of bladder, urethra, and prostate (enlarged). Shows how the urethra is to be regarded as the proper continuation of the bladder in an antero-posterior direction, and how the prostate is formed by the splitting up of the four outer tunics of the bladder.

1'. Longitudinal fibres of first layer splitting up at cervix—a certain number (*a a'*) investing the prostate (*q*) on its dorsal aspect; some proceeding to the dorsal surface of the urethra (*b b'*), and some (*c'*) to the under or ventral surface of the prostate (*q'*).

2'. Slightly oblique spiral fibres of second layer splitting up (*d*), and passing into the substance of the prostate (*d' d' d'*) and into the second layer of the urethra (*e e*).

3'. Oblique spiral fibres of third layer splitting up (*f*); some passing through the prostate (*f' f'*), others proceeding to the third layer of the urethra.

4'. Cut ends of a portion of the very oblique spiral fibres of fourth layer, forming the so-called circular fibres of the prostate (*g g'*), the remainder occupying the centre of the walls of the urethra.

1, 2 & 3. The three external layers of the bladder and urethra.

4. The central or circular layer. A portion of each of these layers, as has been explained, go to form the prostate.

5, 6, & 7. The three internal layers of the bladder and urethra. These layers are peculiar to the urethra, and are quite distinct from the three external layers forming the prostate and the outer half of the urethra, unless in the region of the verumontanum, where they are more or less blended with them.

Diagram 9 illustrates the structure of the prostatic portion of the urethra, and the relation of the ureters to each other and to the urethra, as seen in the inverted bladder.

a. Longitudinal submucous fibres continued on the urethra.

b. Ditto, posterior longitudinal fibres.

c. Slightly oblique spiral fibres curving forward on the urethra.

g. Ditto, oblique spiral fibres.

z. Similar fibres from the right ureter.

v. Very oblique spiral fibres from the left ureter curving round the urethra (*l*).

s. The fibres of the right ureter passing across to join with those of the left in the mesial line (*b*).

Diagram 10 shows the conformation of the fundus and the bilateral nature of the sphincter in the inverted bladder, the prostatic portion of urethra being removed. In this diagram the anterior and posterior sets of fibres only are shown.

a b. Anterior and posterior longitudinal submucous fibres.

l l l, *l l l*. Terminal expansions or loops of the very oblique spiral fibres forming the fourth layer at the fundus posteriorly, and especially concerned in the formation of the anterior lip of the sphincter (*l'*).

y y y, *y y y*. Terminal expansions or loops of the very oblique spiral fibres forming the fourth layer at the fundus anteriorly, and especially concerned in the formation of the posterior lip of the sphincter (*y'*).

r and *s*. Spiral oblique fibres from the right and left ureters (*z v*), which give off filaments to assist in the formation of the sphincter (*l' y'*).

Diagrams 11, 12, 13, 14, 15, 16, 17, 18, & 19. Accurate outline sketches of transverse sections of male prostate and urethra, showing the precise shape and degree of obliquity in the urethral canal at different points, and the part which the verumontanum plays in the closure of it. (Dissections preserved.)

a. Urethra at base of prostate, oval in shape, and quite open.

b. Urethra a little further forward, oval, floor (*j*) slightly elevated.

c. Urethra somewhat triangular in shape; the verumontanum (*k*) beginning to project from the floor or base of the triangle.

d and *e*. Urethra more decidedly triangular, the verumontanum (*l* and *m*) projecting to such an extent as almost to obliterate the urethral canal.

f and *g*. Urethra bayonet-shaped and entirely closed by the projection of the verumontanum (*n*, *o*), which acts at this point as a mechanical wedge.

h i p q. Urethra circular in form and again becoming patent.

Diagram 20. Sketch of preparation showing the anterior (*l*) and posterior (*y*) lips of the sphincter at the cervix.

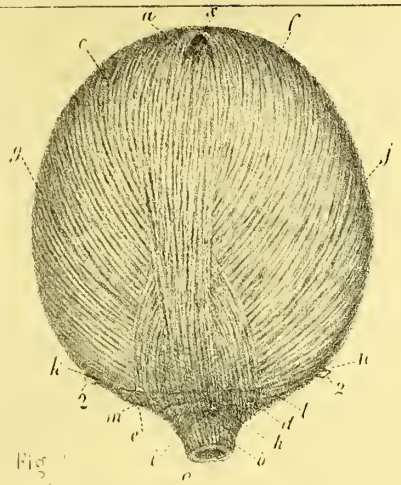
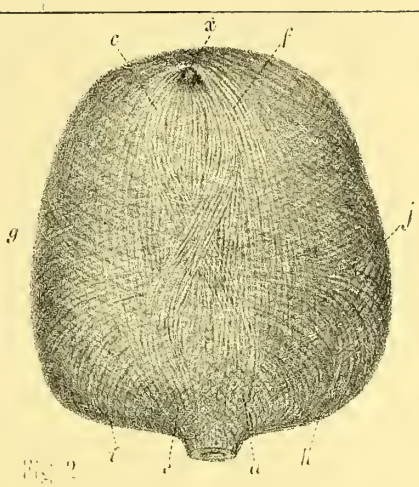


Fig. 1.



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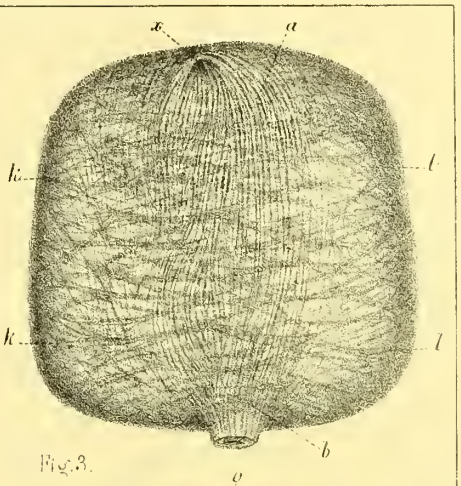

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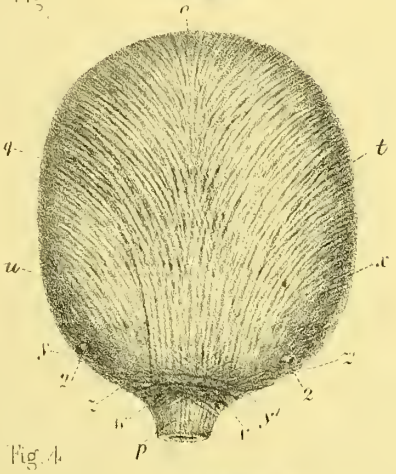

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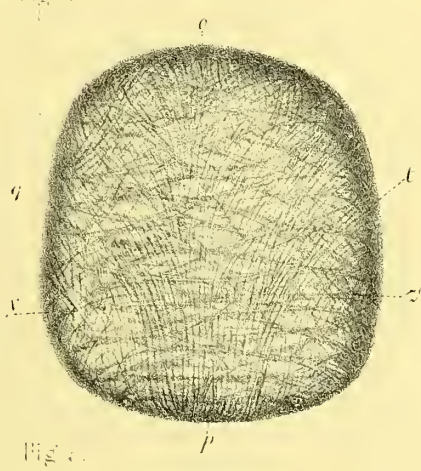

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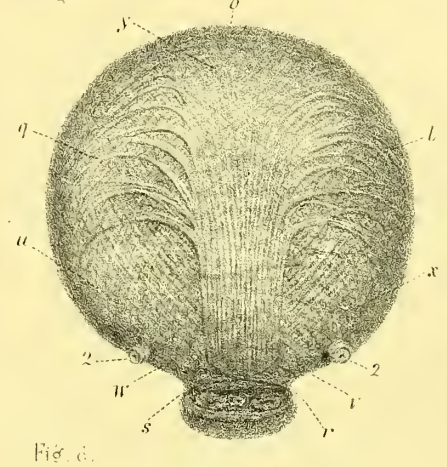

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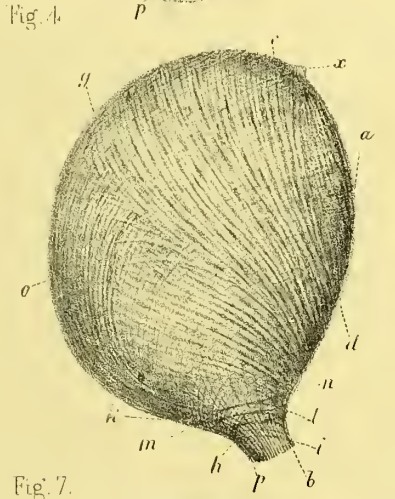

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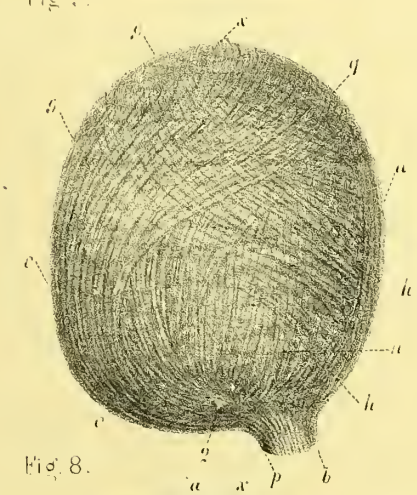

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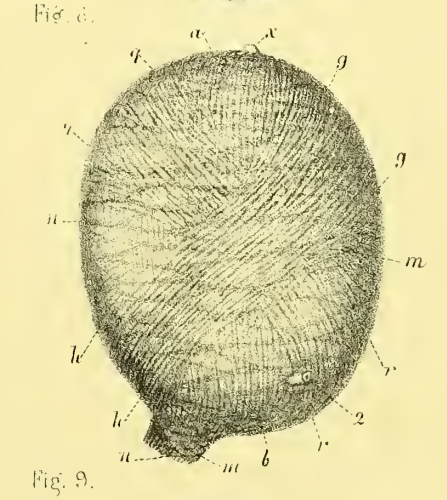

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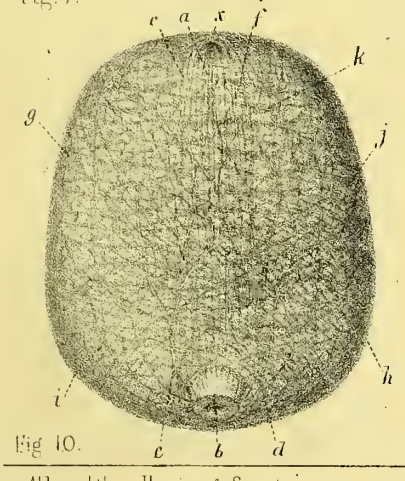

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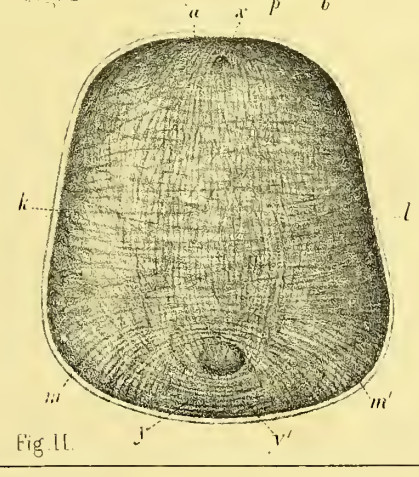

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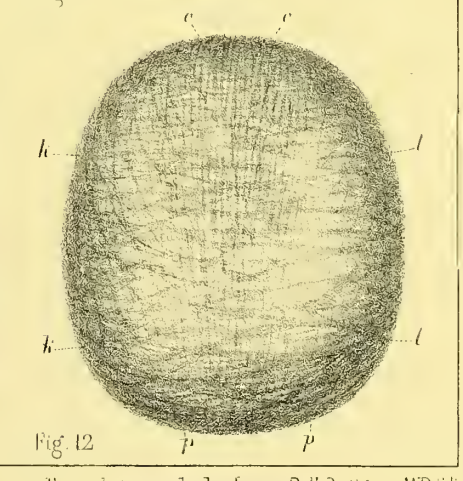
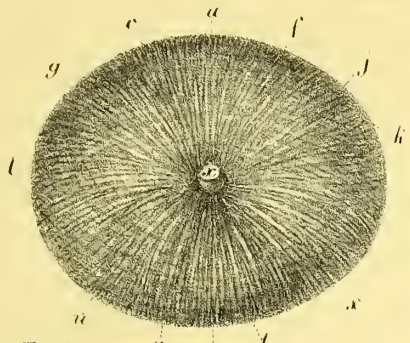


Fig. 12.

Tiens Aldous, lith. Harrison & Sons imp. From photographs by James Bell Pettigrew M.D. Edin.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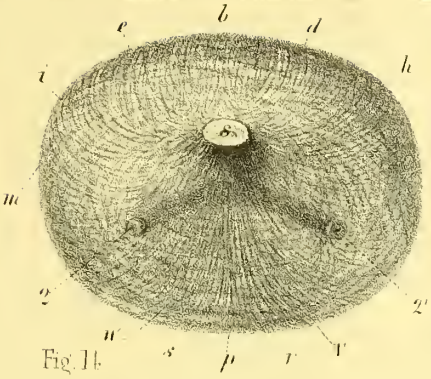
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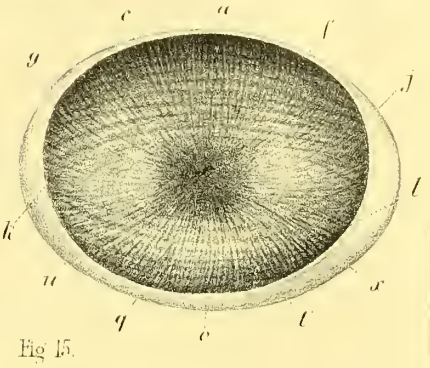
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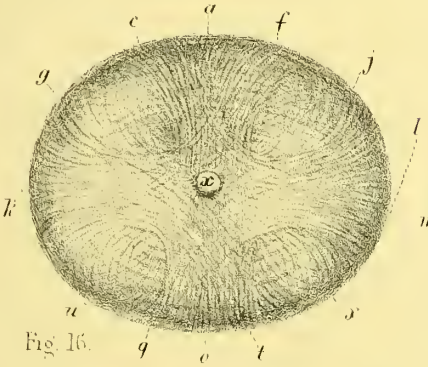
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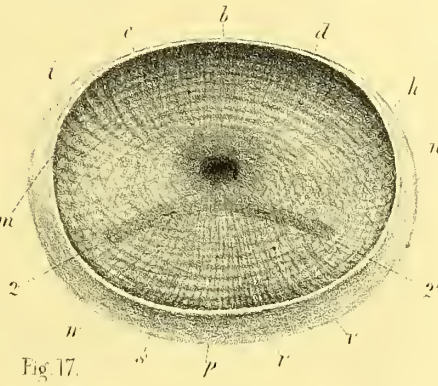
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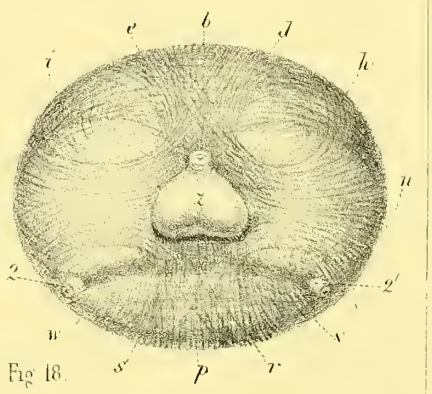
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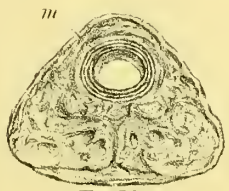
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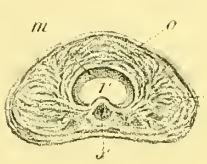
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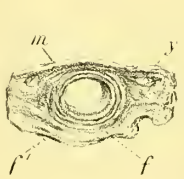
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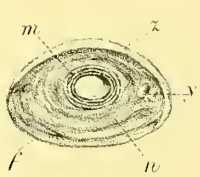
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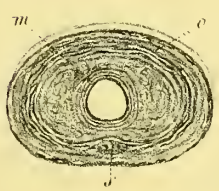
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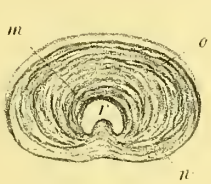
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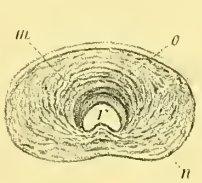
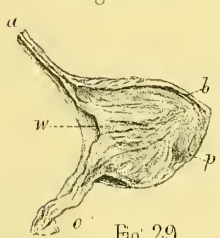


Fig. 26.


Fig. 27.


Fig. 28.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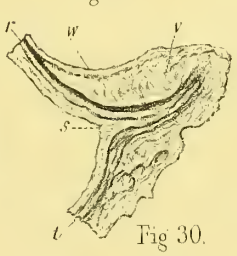
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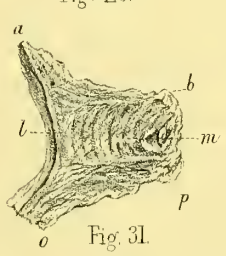
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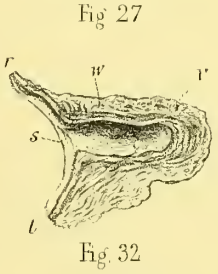
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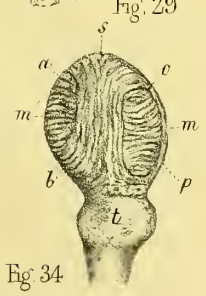
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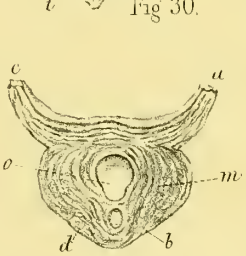
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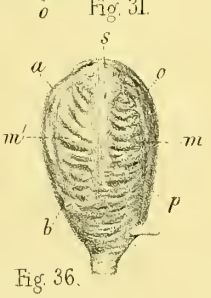
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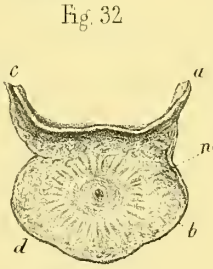
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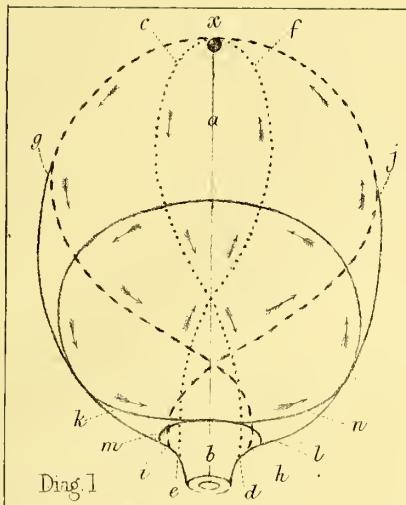

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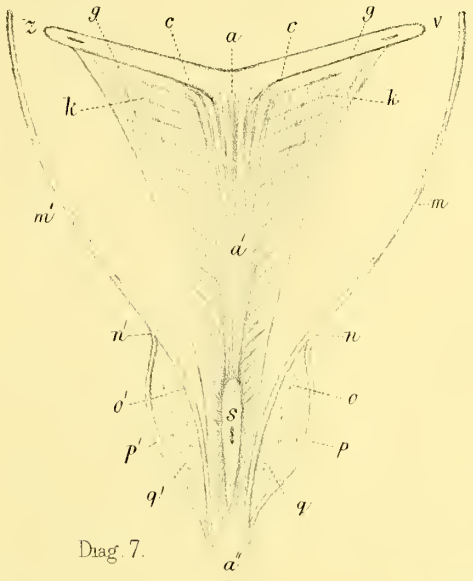

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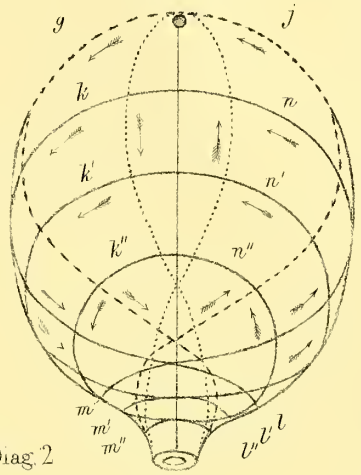

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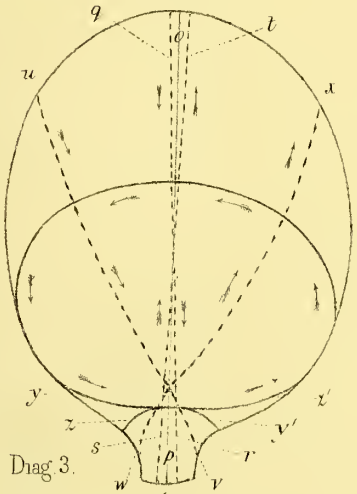

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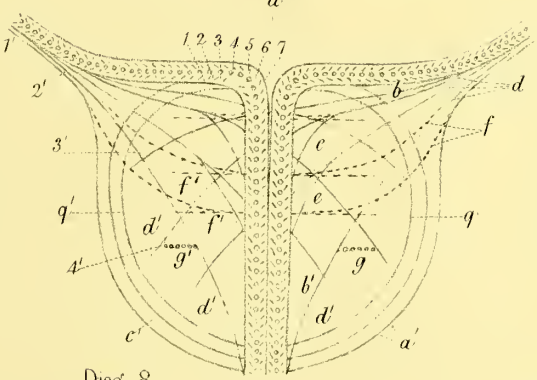

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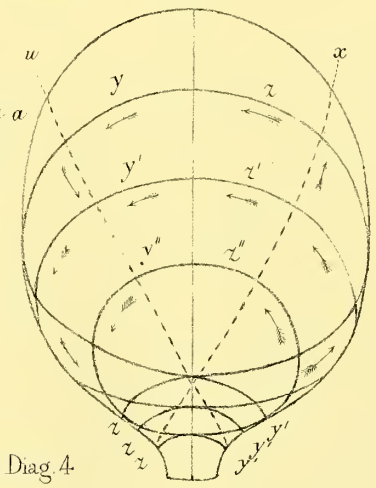

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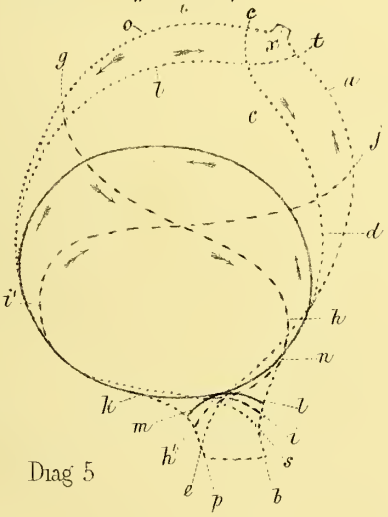

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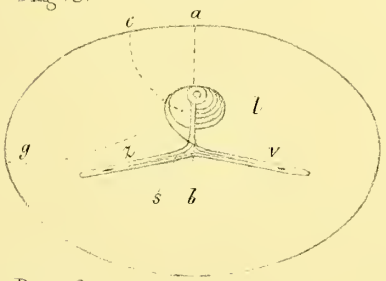

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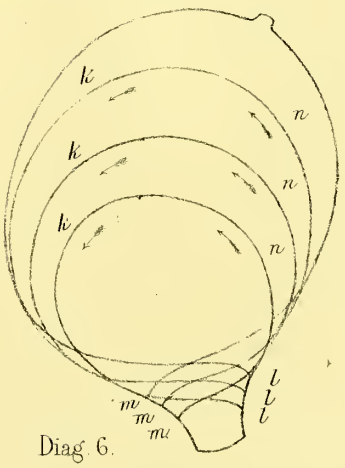

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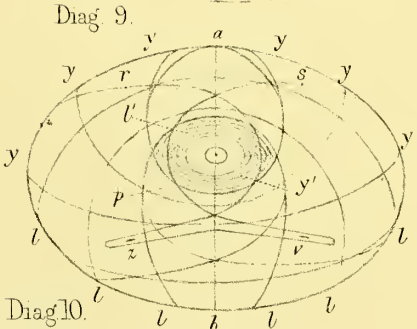

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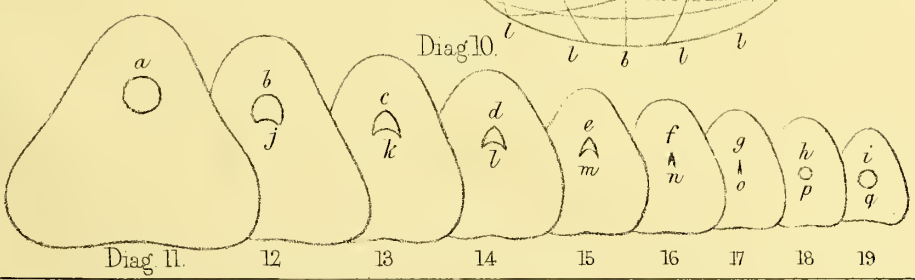

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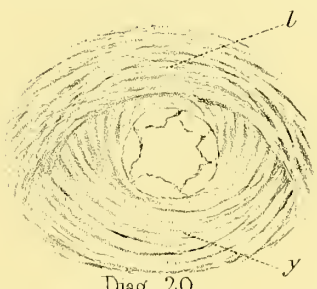

Diag. 20.

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